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ABSTRACT

This publication describes thirty-three simulation games discussed at the 9th Symposium of the Council in April of 1970. Those articles related to the social sciences are: 1) Teaching Economics with Competitive Games; 2) An Economic Strategy Analysis Game; 3) A Social Simulation Strategy for Researching the Israeli Arab Conflict; 4) The Use of Simulation Games in Instruction; 5) Simulation in High School Geography; 6) The Carolina Population Center Family Planning Policy Game; 7) Economics of the Environment Decision Model: A First Step; 8) The Design Dilemma: Social Science Games for whom; 9) Gaming Simulation of Urban Spatial Processes; 10) The Connecticut Game; 11) Fun City: An Urban Planning Game; 12) Two Urban Election Simulations and Urban Analysis; 13) Urban Game Design; 14) Simulation Games in Social Science Teachings and Research; 15) Learning Games in the DePaul College; 16) Simulation in Behavioral Research and Training in the Field of Special Education Administration; 17) Build: A Community Development Simulation Game; and, 18) Czechoslovakia 1968: A Simulation. Other types of simulation games include: war, finance, community emergencies, naval operations, air defense, industrial management, fire protection, and bridge playing. (SBE)

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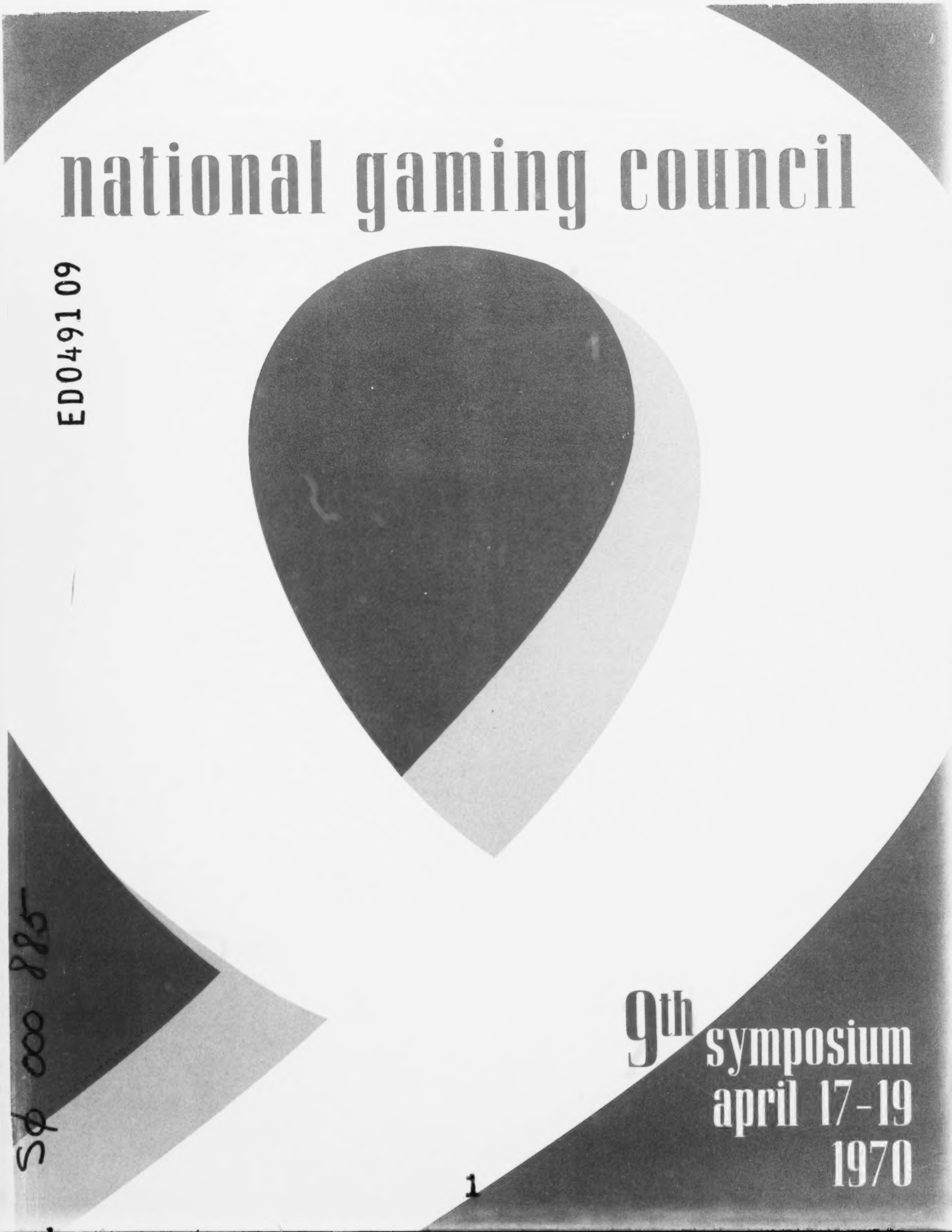

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9th symposium

april 17-19
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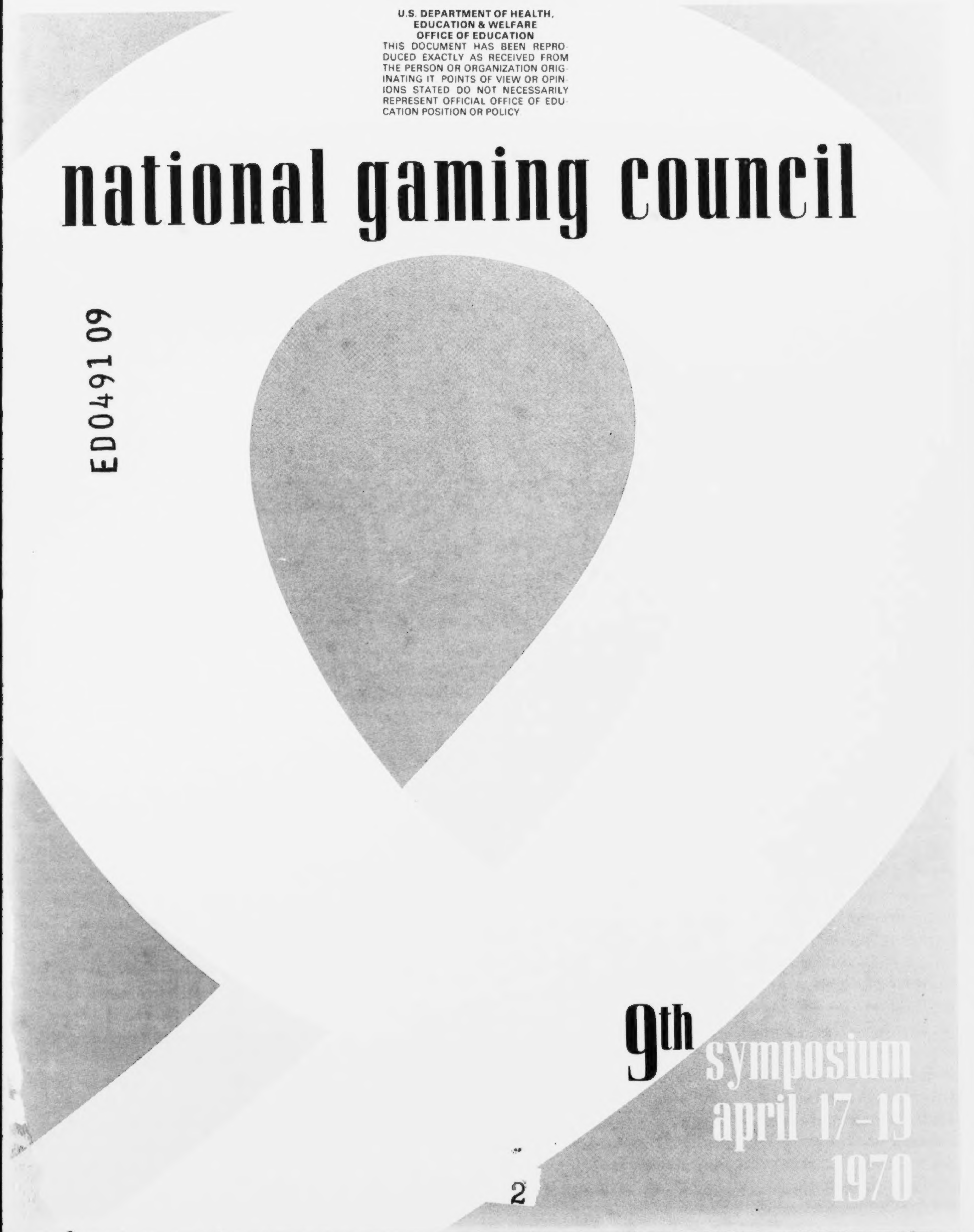

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THE MATERIAL PRESENTED
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OF THE
RESPECTIVE AUTHORS.

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CONTENTS

PREFACE	Peter W. House
META MODELING AND WAR GAMES	George Armstrong
GENERALITY IN A MAN-COMPUTER GAMING MODEL	Richard F. Barton
TEACHING ECONOMICS WITH COMPETITIVE GAMES	Martin Shubik
A FINANCIAL MODEL FOR A COMMERCIAL BANK	Robert P. Beals
AN ECONOMIC STRATEGY ANALYSIS GAME	James A. Zwerneman
A SOCIAL SIMULATION STRATEGY FOR RESEARCHING THE ISRAELI-ARAB CONFLICT	Joseph D. Ben-Dak
LOW-LEVEL GAMING IN A COMMUNITY EMERGENCY OPERATIONS SYSTEMS DEVELOPMENT CONTEXT	Charles J. Davis
THE USE OF SIMULATION GAMES IN INSTRUCTION	Jerry H. Fletcher

SIMULATION IN HIGH SCHOOL GEOGRAPHY	ANGUS M. GUNN
THE CAROLINA POPULATION CENTER FAMILY PLANNING POLICY GAME	THOMAS H. NAYLOR, ARNOLD H. PACKER AND R. SCOTT MORELAND
ECONOMICS OF THE ENVIRONMENT DECISION MODEL: A FIRST STEP	JAMES J. SULLIVAN
COURSES AND MASTER THESES RELATED TO SIMULATION IN THE OPERATIONS RESEARCH CURRICULUM AT THE NAVAL POSTGRADUATE SCHOOL	ALVIN F. ANDRUS
SEA WARFARE INTEGRATED MODEL (SWIM)	L. F. BESIO
A COMPUTER-ASSISTED GAME FOR THE EVALUATION OF AIR DEFENSES IN A COMBAT ENVIRONMENT	JOSEPH BODO
THE USE OF CARMONETTE IN EVALUATING THE EFFECTIVENESS OF NIGHT VISION DEVICES	NORMAN W. PARSONS
STOPS: A STABILITY OPERATIONS SIMULATION	R. E. ZIMMERMAN
THE DESIGN DILEMMA: GAMES FOR WHOM?	HAROLD W. ADAMS
GAMING SIMULATION OF URBAN SPATIAL PROCESSES	BARRY M. KIBEL

THE CONNECTICUT GAME	Dennis Little
FUN CITY: AN URBAN PLANNING GAME	David Seader and K. Michael Burke
TWO URBAN ELECTION SIMULATIONS AND URBAN ANALYSIS	Marshall H. Whithed and Clifford N. Smith
URBAN GAME DESIGN	Paris Glendening
PROBLEMS IN VALIDATION OF FUTURE CONCEPTS	Norman Farrell
VALIDATION OF COMBAT MODELS AGAINST HISTORICAL DATA	William Fain, Janice Fain, Leon Feldman and Susan Simon
FITTING KOREAN WAR DATA BY STATISTICAL METHODS	John Overholt
INDUSTRIAL MANAGEMENT TRAINING GAMES - THEIR USE AND VALIDATION	Virgil Rehg
MODELING THE FIRE PROTECTION DELIVERY SYSTEM	Dennis J. Corelis, Robert J. Esposito and Edward M. Gans

SIMULATION GAMES IN SOCIAL SCIENCE TEACHING AND RESEARCH	FRANK B. HORTON III AND ALAN R. THOENY
LEARNING GAMES IN THE DEPAUL COLLEGE	NANCY KLEIN
SIMULATION IN BEHAVIORAL RESEARCH AND TRAINING IN THE FIELD OF SPECIAL EDUCATION ADMINISTRATION	DANIEL D. SAGE

GAMING DEMONSTRATIONS

BRIDGE PLAYING GAME	WINSTON RILEY III AND THOMAS A. THROOP
BUILD - A COMMUNITY DEVELOPMENT SIMULATION GAME	J. A. ORLANDO AND A. J. PENNINGTON
CZECHOSLOVAKIA 1968: A SIMULATION	JOHN P. MCABEE

PROGRAM OF EVENTS

PREFACE

Ninth Symposium -- An Experiment

Since this preface is obviously being written before the symposium, I am going to discuss what we hope to accomplish at the meeting.

As gamers, by definition, are action-oriented individuals, their symposium should reflect their activity. We will try to actively involve all the participants -- both the speakers and the audience -- in two basic ways.

First, each session chairman has created a general theme to enable the audience and the speakers to discuss a subject relevant to the session. The speakers can focus their presentation toward that general topic, if they desire. We think a two-fold purpose is thus achieved. The audience learns about the speaker's specialty, and has an opportunity to exchange views on a topic relevant to them both.

Second, the physical set up of the symposium will encourage dialogue. An arena seating arrangement whereby the speakers are seated at a round table encircled by the audience should help create an informal atmosphere, and thus aid audience participation in the sessions.

Also, demonstrations of games -- in various fields will allow attendees to participate in the games designed and built by their fellow gamers.

You will note that the last item on the program is an informal discussion on the future organization of the Council. Up to now, a handful of individuals have been responsible for the Council's activities. With more and more people becoming interested and involved in gaming and simulation, it seems to be time to shift the leadership of the organization to the public sphere. Admittedly, it is more difficult for a university to sponsor a symposium than it is for a corporation, but it has and can be done. We hope that many interested members will attend the discussion which will be only as long as necessary.

Gamers are action-oriented creative persons. If anyone thinks that he has a better plan for a symposium, we invite him to create his own experiment at the Tenth Annual Symposium.

Peter House, Chairman
Ninth Symposium
National Gaming Council

"META MODELING AND WAR GAMES"

George Armstrong
USA Strategy & Tactics Analysis Groups

META-MODELING AND WAR GAMES

Mr. George E. Armstrong and Captain John A. Battilega
US Army Strategy & Tactics Analysis Group

Introduction

"Meta-modeling" is a coined word. It is derived from the prefix "meta"--a later or more highly organized form--and "model".

The word "model" means different things to different people. As used in this paper it will be defined as follows:

A program containing all rules, procedures and logic required to conduct a war game.

A representation of a real situation in which only those properties believed to be relevant to the problem being studied are represented.

Thus a "meta-model" is a later, more highly organized form of the original model--or, more simply,--a model of a model.

The concept of meta-modeling is not new. Manual quick-game techniques--a form of meta models--are commonly used. However, the application of meta-modeling in computerized war gaming has been limited. The United States Army Strategy and Tactics Analysis Group (STAG) recently had occasion to explore the feasibility of meta-modeling as a step in testing its large and complex computerized expected-value simulation model, ORION.

The ORION Model

To appreciate the significance of the meta-modeling technique in this instance, an understanding of some of the background and salient features of ORION is in order, as well as some of the problems involved.

Background

By 1967 computerized war gaming models had been created for simulating many aspects of military operations dealing directly with combat operations. Ground combat, air combat, air defense, nuclear assessment and target acquisition had all been addressed in varying degrees of detail. Even logistical support--less fascinating and more cumbersome--had received some attention. Dynamic interactions between the two, however, had largely been relegated to the back burner. As a result, measuring the impact of the aerial interdiction of lines of communication on the ability of theater forces to carry on a war was still a tedious manual assessment, heavily dependent on judgement, and not responsive in time.

The Chief, STAG was long aware of this gap. In June 1967 he initiated a project to prepare a computerized model--ORION--to alleviate this problem.

The Administrative Problem

ORION was basically developed by a contractor, Midwest Research Institute. The model was coded in the SIMSCRIPT I.5[1] programming language and was originally intended to be used on STAG's IBM 7090 computer system. Because of the size and scope of the model, it was plagued by a host of both hardware and software problems throughout its development, with the ultimate result that the model, if it was to accomplish the purpose for which intended, could not be used with STAG's computer system. Core storage requirements were far in excess of the system's capabilities, and a larger system was required. For a number of management reasons, the model was ultimately specifically tailored to be used with a UNIVAC 1108 computer system. Thus, when STAG commenced testing the model, administration was one of the governing factors. Availability of a UNIVAC 1108, the attendant ramifications of cost, turnaround time, travel, and compatibility of operating systems all had to be taken into account.

The Problems of Size and Complexity

A second significant problem area was the size and complexity of the model itself. The ORION program contains 201 arrays and uses more than 300 variables, for which over 900 values must be initially input. Most of these values are expected-value estimates of physical parameters. There are 51 subroutines in the program which interact with each other to simulate the dynamics of movement of supplies and aerial interdiction, keep records, and write out reports.

The Logistical Network

By input, the gamer describes a surface logistical network consisting of nodes and links. There are 8 types of nodes--highway nodes, ports, pipeline nodes, transshipment points, depots, rail nodes, inland waterway nodes, and airfields. Supplies originate at ports and move over the logistical network either directly to depots or to transshipment points where they are stored or transloaded for onward movement to depots.

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[1] Markowitz, Hausner and Karr; "SIMSCRIPT, A Simulation Programming Language"; Prentice-Hall, Englewood Cliffs, New Jersey, 1965.

Supplies

ORION deals with five classes of supply. Four of these--Ammunition, POL, General, and Other--are used to describe types of materials being moved by the several modes of transport or stored at appropriate nodes. The fifth class has two different meanings. When used as a descriptive attribute of a convoy, it signifies that the convoy is empty. When used as a descriptor of a node as a target, it means facilities at that node--i.e. cranes, derricks, lock controls, pumping equipment for POL and so on.

Supplies flow into ports and out of depots to reflect theater resupply and demand respectively. Amounts into ports and out of depots daily are constants input by the player. Neither the inflow of supplies into ports on inter-theater shipping nor outflow on division convoys from the depots is modeled. Thus the ultimate destination of all supplies within the model logic is the forward depot. The demand, or outflow, at the forward depot is the amount required to support all forces which that depot serves. This demand represents a reduction in the stock on hand at the depot. As such, it is the principal variable which initiates simulation of flow of supplies through the system. Once supplies leave the depot they are considered to have been consumed and are dropped from accountability.

Modes of Transport

Four modes of transport are modeled--highway, rail, inland waterway, and pipeline. In each of the first three, resources in the form of trucks, railroad cars and barges are allocated by the player to each port, transshipment point and depot. The pipeline mode simulates movement of bulk POL through a network of pipelines, pumping stations and tank-farms.

In response to the demand for supplies at the forward depots, convoys are created at the nearest transshipment point or port, loaded with an appropriate mix of supplies, and dispatched. They move over the logistical network, working their way forward by the best available route to the requesting depot, where they unload, and then return to their point of origin by the same procedure.

Aerial Interdiction

The logistical network, the convoys using it, and supplies stored or transported along it are subject to interdiction by enemy aircraft. Two types of aerial attacks are modeled - node attack sorties and link patrol sorties.

Node attack sorties are directed against nodes themselves and inflict damage on the facilities at these nodes and supplies stored there. Throughput capacity of the node is also reduced according to the amount of damage inflicted. If a convoy in in process at a node when the node is attacked, damage is assessed against the convoy vehicles and the supplies being carried, as well as against the node.

Link patrol sorties overfly a series of assigned links searching for convoys. If a convoy is detected, the sortie attacks the convoy and damage is again assessed against vehicles and supplies.

This description of ORION touches only the high points. Refinements and details of the many algorithms for loading, dispatching and unloading convoys, automatic route selection, convoy detection, node repair, dispatch of aircraft, damage assessment and the attendant updating of statistical records are too numerous to describe here. However, the reader should have little difficulty in recognizing that the model is indeed comprehensive and complex.

The Testing Problem

The foregoing administrative and model complexity problems combined to make initial debugging and logic testing a long and frustrating effort. However, these problems were eventually overcome and the model successfully "cycled" on a UNIVAC 1108 computer system.

Two different sets of data inputs, prepared independently, were used during these preliminary tests. One set, made up by contractor personnel for their own use in debugging, contained arbitrary values not intended to portray any specific scenario. The second set, prepared by STAG, comprised carefully researched and coordinated data reflecting a real world situation. This second set--the STAG data--required approximately four man-months to prepare, again demonstrating the complex nature of ORION.

After the model had successfully run to completion with both sets of data and produced mathematically correct results, it was ready for the final crucial step--The User Test. This is the test by the wargamers--in this case experienced military officers--in which they use the model to solve the type problem for which it was designed and make a critical evaluation of its usefulness based on results and their experience in using it. Their evaluation directs itself to answering three questions.

Does the model perform the intended function?

Are results realistic (i.e. is the output credible, valid, and in a usable form)?

Is the model a worthwhile working tool to enhance STAG's wargaming capability?

Designing the User Test

The practical problem confronting the User Test Team was to design a testing procedure which would definitively answer these questions without excessive investment of time, manpower and money.

Selecting the "Most-Important Variables"

The Test Team reasoned that, since there were more than 900 input variables required for this model, it would be exceedingly difficult to test them all. By eliminating all those which served only control purposes--flags, place names, report headings, etcetera--which had already been found satisfactory during debugging and logic testing, they narrowed the field to 600-plus. Further reasoning that, among these, there were a certain number which would be obviously more important in the real world, they set about selecting a subset of "most important" variables by a process of elimination. Ultimately a subset of sixty-six "most important variables" was chosen to be subjected to sensitivity analyses. Further, physical and real-world operational considerations permitted development of a credible range of values for them.

The Testing Method

Having selected the 66 "most importent" variables and a range of possible values for each, the team decided to make a series of full-scale production runs of the model, using different values for "the 66" in each, to create a data universe which would be amenable to some type of matrix analysis. In two of the production runs the input values would be deliberately biased in a manner calculated to portray, respectively, the maximum and minimum possible effectiveness of the logistical system. Outputs of these two runs would establish a range of values within which all other run results should be valid.

Because ORION is an expected-value model, it was anticipated that a small number of production runs would suffice. Time and cost considerations also imposed a practical constraint, and the team settled on ten runs in addition to the maximum and minimum runs described above, as a population sample to generate the desired data universe. In each of these ten intermediate runs, values of the 66 most important variables would be changed in pseudo-random manner to eliminate bias on the part of the analysts. Each of the twelve production runs would be a 13 game-day simulation using the real-world scenario prepared by STAG for the earlier debug and logic testing. The first three days would be used to "load" the logistical network and the remaining ten would simulate continuing network operations subjected to aerial interdiction.

Upon completion of these twelve production runs, the data universe would be subjected to sensitivity analysis.

The Stepwise Multiple Regression Routine

The mathematical model chosen for the sensitivity tests was a least-squares Stepwise Multiple Regression routine (SHARE Computerized Program ERMPR3).[2] This routine was immediately available and readily adaptable for use with STAG's IBM 7090 computer system.

This program determines, for a single "dependent" variable, Y, the relative importance of as many "independent" contributory variables, X, as the analyst may choose to consider (up to 130).

An equation of the form

$$a(1)x(1) + a(2)x(2) + a(3)x(3) = Y$$

is derived from the Stepwise Multiple Regression program. When the coefficient for each independent variable is multiplied by the value of that variable, and these products are summed, the result is an estimate of Y.

Given a set of candidate independent variables x(1), x(2), x(3)... x(n), the program determines the most important independent variable first, then selects the remaining independent variables, in descending order of importance, until those which contribute to explaining most of the change in the dependent variable have been found.

The ERMPR3 routine also calculates the coefficient and multiple correlation coefficient for each of the independent variables it has determined to be the most significant. For example, if it has

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2. ERMPR3, Share Program Catalog, SDA Number 3145, "Stepwise Multiple Regression with Variable Transformation", 6-10-64.

identified three independent variables, [x(1), x(2), and x(3)], as significant, the output might appear as follows:

Variable	Coefficient	Multiple Correlation Coefficient
X(1)	0.5	0.78973
X(2)	0.8	0.93599
X(3)	0.3	0.99991

The multiple correlation coefficient (MCC) is a measure of the percentage of the change in the value of the dependent variable that can be explained by the significant independent variables to that point. The final MCC is a measure of how well the final value of the dependent variable can be estimated.

The Meta-Model

When the dependent variable, Y, represents a significant output of a detailed computerized war game model and the set of candidate independent variables, X(i), represent inputs to the detailed model, the resulting equation is a meta-model.

The equation used above to illustrate the meta-model--which was the same one used in the ORION sensitivity tests to be described later--was linear in the input variables. However, this cannot be assumed true in general. If a meta-model linear in the input variables would not provide a good fit, transformations of input variables could be generated and used as independent variables in developing a more complex meta-model. If a more complex meta-model should be required, the nature of the situation being simulated by the detailed model could suggest appropriate transformations. In general, if $\overline{x}$ is the vector of input variables obtained from the detailed model, any equation of the form

$$Y = a(0) + \sum_{i=1}^{N} a(i)\ f_i\ (\overline{x})$$

can be tried, providing that f_i $(\overline{x})$ is defined over the assumed range of $\overline{x}$.

Conducting the Sensitivity Tests

Having created a data universe with the twelve full scale production runs of ORION on a UNIVAC 1108 computer, the test team utilized selected data from this universe to conduct a series of sensitivity tests with the Stepwise Multiple Regression routine.

Procedure

The first step was to select a single dependent variable from ORION which would constitute a meaningful measurement criterion in real-world terms. In most of the sensitivity tests, for example, the dependent variable chosen was "total tonnage of supplies received at depots". This figure was readily available in ORION output for each game day in each of the 12 production runs, and was considered to be the most realistic real-world criterion.

The 12 sets, each consisting of one value for the dependent variable and one for each of the 66 independent variables were then processed by the Stepwise Multiple Regression routine. Initially a meta-model, linear in the input variables, was assumed. This model resulted in a very high multiple correlation coefficient in a small number of variables. This provided a suitable fit and a more complex meta-model was unnecessary.

Results

The User Test Team made seven sensitivity test runs with this procedure. Preparation of inputs required about 2 1/2 man hours, including time to punch the data cards. In each case, the Stepwise Multiple Regression routine found that only a very few of the sixty-six variables believed most important were truly critical in determining output from the major ORION program. In one of the tests only five critical variables were found, and in no case were there more than eight. The multiple correlation coefficient in each case exceeded .99.

These sensitivity tests had two valuable results. One was that they quickly pointed out which variables did and did not influence the outcome of the ORION simulation. This was a material aid to the Test Team in their assessing the validity of the model. It permitted a comparison of those factors which most affected tonnage throughput in ORION with those known to affect tonnage throughput in the real world. The second valuable result was the creation of the meta-model, which can be used to estimate the impact of changes in the most significant variables, without having to re-run the entire major model.

It must be stressed that the critical variables selected by the Stepwise Multiple Regression process are valid only for the logistical network and interdiction systems described in the production runs of the ORION program used. A different list of ccrtical variables may result from significant scenario changes. The important point is that, based on their analysis, the list can be expected to be small--which implies that ORION treats these few in an exacting manner and is relatively insensitive to the rest. Hence the emphasis in initial data preparation should be on these few critical variables.

Summary

The concept of meta-modeling--making a model of a model--is not new but its application in computerized war gaming has been limited. STAG explored the feasibility of meta-modeling in testing a carefully selected segment of its large and complex model, ORION, which simulates the operation of a theater ground logistical network and the aerial interdiction of that network.

Using a data universe created by twelve runs of the full-scale model on a UNIVAC 1108 computer, the test group then made a series of sensitivity tests of the sixty-six most important variables in a set of over 600. The purpose of the sensitivity tests was to determine which of these variables most influence the outcome of the simulation.

Sensitivity testing of the selected variables was made by processing them through the SHARE Stepwise Multiple Regression Program ERMPR3. It was found that 99-plus percent of the variation in the most significant output variables in ORION could be determined from a very small number (5 to 8) of the input variables.

These sensitivity tests had two valuable results. First they established which variables did and did not significantly influence the outcome of the simulation. This result was a valuable aid to the military analysts in assessing validity of the model because it permitted them to compare what most affects tonnage throughput in ORION with what most affects it in the real-world.

The other valuable result was the development of a meta-model, in the form of a simple equation, which could be used to estimate the impact of a change in value of any of the critical variables on the final outcome of the simulation, without having to again run the full scale model.

Potential Applications

Other potential applications of the sensitivity test procedure and the meta-model developed from it are readily apparent.

A whole range of dependent variables could be examined to find which independent variables are critical, and to develop an equation--or meta-model--with which to test a change in values of the latter. Conversely, the analyst can infer that an independent variable that is never selected as being critical has no appreciable effect on the final outcome.

For those variables which the test has indicated are critical, experimental values can be substituted in the meta-model and the effect readily gauged by the resulting change in the dependent variable. In the case of ORION, for example, the approximate effect of changing the capacity of truck convoys from 200 tons to 210 tons, or increasing the weapon standard error in the x-dimension for the CBU cluster from 25 meters to 40 meters, could be determined in a minute or two by the analyst with a desk calculator.

Just as this procedure was found useful with ORION it could be equally useful with any complex model. An expected-value model is particularly suited, since the number of repetitions required can be expected to be significantly fewer than in a Monte Carlo simulation.

The practical implications of a family of meta-models corresponding to a collection of detailed models would perhaps best be observed in terms of the time required to solve a real-world war gaming problem. Typical war gaming requirements can usually be solved only by using several detailed models in series, with feedback as required. Past experience at STAG has shown that several trial runs ("false starts") are usually required before the approximate proper mix of operational elements can be obtained. These false starts may require hundreds of man-months for detailed models. However, with a family of meta-models, an approximate operational environment could be obtained very quickly, thus either allowing more time for detailed gaming, or reducing the overall time required for a given game.

Conclusion

The time saved and the range of examinations possible by meta-modeling can only improve the validity of information made available to the decision-maker and expedite its preparation. Obviously, the result must be a more valid decision.

After all, better and quicker decision-making is the name of the game. That is what war gaming is all about.

"GENERALITY IN A MAN-COMPUTER GAMING MODEL"

Richard F. Barton
Texas Tech University

GENERALITY IN A MAN-COMPUTER GAMING MODEL

Richard F. Barton
Director of Planning and Analyses
Texas Tech University
Lubbock, Texas

Introduction

This paper first describes features of a "generalized" man-computer management game developed intermittently over an eight-year period and then reports a case history of adapting this game model, which was designed for ideal generality, to an application that challenged that very generality. The game was named THE IMAGINIT MANAGEMENT GAME[1] because the coined word Imaginit (Imagine it!) suggests the degree of generality the model was intended to accommodate. Strategies in game model design and in computer programming to achieve this generality were developed, including a method for using a generalized responsiveness subroutine.[2]

Generality aspirations of gamesters might be summarized as follows: If a game designer were successful in creating for his purposes a once-and-for-all model so general that only players and perhaps some data need be changed from application to application, he would save himself, his colleagues, and his subsequent game users a great amount of model tinkering and computer programming. Also, players from application to application would not endure the frustration of participating in quasi-pilot runs.

History of THE IMAGINIT MANAGEMENT GAME

It is probably a fair but unfounded guess that many management game writers were once dissatisfied game users who wrote their own games. That is how THE IMAGINIT MANAGEMENT GAME was born. During a course in business policy at the University of Nebraska, the game the author was using suffered an involuntary industry depression due to a program error. The computer at Nebraska was then a vacuum-tube Burroughs Datatron 205, and the only available management game was an ALGOL translation of UCLA Game #2, which had been designed for four firms. The ALGOL programmer had wanted to extend the capacity and interaction of UCLA #2 to more than four teams, which he did handily except for providing increased total sales volume for the added firms. This writer launched a play of this game for nine teams. The result was that each company quickly dropped to four-ninths of its starting sales volume with consequent damage to player motivation.

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[1] Described in: Robert G. Graham, and Clifford F. Gray; Business Games Handbook; New York: American Management Association; 1969: 211-213.

[2] Richard F. Barton; "A Generalized Responsiveness (Elasticity) Function for Simulations"; Behavioral Science, Vol. 12 (July, 1967): 337-343.

This experience was a strong influence on this game administrator to write his own game, which he did. The first version was written in ALGOL. (Compile time for four segments was then more than four hours compared to present-day three to four minutes.) This was a trying but rewarding experience. Amazingly, on the first "object time" run out of the compiler, the balance sheet actually balanced. In contrast to this success, in the first semester run with live players, the stock market quotation went negative.

The ALGOL computer coding of the first IMAGINIT model was done in two-dimensional arrays and was a horror to debug to obtain corrected reports when flukes appeared during live runs. Fortunately, playing the game over an entire semester allowed adaptive debugging time. (This was hands-on time during the midnight hours. Remember, compile time was four hours.)

From the outset, the IMAGINIT vehicle was designed to accomodate any manufacturing industry. It was called IMAGINIT to mean imagine any industry and then play it as a game. (One wry professor read IMAGINIT to mean, "I'm agin' it.") Within its first two years, IMAGINIT had simulated the typewriter industry, the automobile industry, a combined dentifrice and hairdressing industry, and grades had been incorporated into computer consequences. The grades were for periodic written reports that amplified player policy positions.

In the meantime, the Burroughs computer gave way to an IBM machine, ALGOL to FORTRAN, and the game writer almost to despair -- but compile times were coming down. A little more than two years after its birth, at the University of Kansas, the IMAGINIT computer program was completely revised. One whole semester was devoted to inventing names for FORTRAN variables that would make sense to almost any reader. Figure 1 shows the present company report form with the FORTRAN names shown instead of output quantities. The underlined names are also input decision variables. Figure 2 shows a portion of the present FORTRAN coding where the chosen names make sense in terms of the simulation design. Figure 3 shows example control parameter descriptions with FORTRAN names designed to make sense to

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     THE IMAGINIT MANAGEMENT GAME               YEAR  4      QUARTER 2      MONTH  0
  THE IMAGINIT TIRE INDUSTRY                       PASSENGER          AIRCRAFT
                                               -----------------    --------    --------
       COMPANY REPORT FOR FIRM I                A-1        A-2        B-1       TOTALS
             INCOME STATEMENT                 -------    -------    -------    -------
  SHIPMENTS IN UNITS OF PRODUCT               SHIP(1)    SHIP(2)    SHIP(3)
  NET SALES REVENUE                            REV(1)     REV(2)     REV(3)      TREV
            COST OF GOODS SOLD
  DIRECT LABOR ($)                           DLABR(1)   DLABR(2)   DLABR(3)     TLABR
  DIRECT MATERIALS                           DMATS(1)   DMATS(2)   DMATS(3)     TMATS
  STORAGE                                                                       STORG
  FACTORY DEPRECIATION                                                          FDEPR
  OTHER FACTORY OVERHEAD                                                        FACOH
           COST TO MANUFACTURE                                                    CTM
  CHANGE IN FINISHED GOODS ON HAND ($)        CHGE(1)    CHGE(2)    CHGE(3)     TCHGE
           COST OF GOODS SOLD                                                     CGS
           GROSS PROFIT ON SALES                                                  GPS
  SALESMEN ($)                             SMEN(I,1)  SMEN(I,2)  SMEN(I,3)      TSMEN
  ADVERTISING                               ADV(I,1)   ADV(I,2)   ADV(I,3)       TADV
  RESEARCH AND DEVELOPMENT                  RAD(I,1)   RAD(I,2)   RAD(I,3)       TRAD
  EMPLOYEE FRINGE BENEFITS                                                        TFB
  OPERATIONS RESEARCH                                                        OPSCH(I)
  ADMINISTRATIVE OVERHEAD                                                       ADMOH
  INTEREST                                                                       TINT
           PROFIT BEFORE INCOME TAX                                             PRFTB
           INCOME TAX                                                            TTAX
           NET EARNINGS                                                         PRFTA
  DIVIDENDS PER SHARE               DIV     TOTAL PAYOUT            TDIVS
  SHARES SOLD                      OFFR     PROCEEDS                PRCDS
           CHANGE IN STOCKHOLDERS EQUITY                                        EQCHG

                                 BALANCE SHEET
  CASH                           CASH(I)      ACCOUNTS PAYABLE            ACPAY(I)
  ACCOUNTS RECEIVABLE           ACREC(I)      SHORT-TERM LOANS            SLOAN(I)
  MATERIALS                     TRAWM(I)      BONDS                       BONDS(I)
  FINISHED GOODS                TFGIV(I)      PAID-IN CAPITAL               CAP(I)
  NET FIXED ASSETS              PLANT(I)      RETAINED EARNINGS              RE(I)
  TOTAL ASSETS                  ASSTS(I)      TOTAL EQUITIES                    TE
     COMMON SHARES        CMMON(I)                 BOOK VALUE        BOOK(I)
                              MARKET QUOTE QUOTE(I)

       CURRENT POLICY AND ENVIRONMENT              ----A----       ----B----
  AVERAGE INDUSTRY PRICES THIS PERIOD                AVPA            AVPB
  CURRENT TOTAL MARKET DEMAND (UNITS)               CVOLA           CVOLB
                                            --A-1--    --A-2--    --B-1--
  SHARE OF MARKET THIS PERIOD              SHARE(I,1) SHARE(I,2) SHARE(I,3)
  POTENTIAL SHIPMENTS NEXT PERIOD           SOLD(I,1)  SOLD(I,2)  SOLD(I,3)
  PRICES                                   PRICE(I,1) PRICE(I,2) PRICE(I,3)
  MATERIALS INPUTS PER UNIT ($)            PARTS(I,1) PARTS(I,2) PARTS(I,3)
  MATERIALS ON HAND ($)                     RAWM(I,1)  RAWM(I,2)  RAWM(I,3)   TRAWM(I)
  MATERIALS ON ORDER ($)                   ORDRD(I,1) ORDRD(I,2) ORDRD(I,3)
  MONTHS UNTIL MATERIALS ARRIVE            ARRIV(I,1) ARRIV(I,2) ARRIV(I,3)
  PRODUCTION LEVELS (UNITS)                PRODN(I,1) PRODN(I,2) PRODN(I,3)
  NUMBER OF FINISHED UNITS ON HAND         STOCK(I,1) STOCK(I,2) STOCK(I,3)
  DISTRIBUTION CHANNEL INVENTORIES         TRADE(I,1) TRADE(I,2) TRADE(I,3)
  PURCHASE OR SALE OF FACTORY CAPACITY                                          EXPD
  LOANS MADE OR REPAID                 BNK    BONDS ISSUED OR REDEEMED          FLTE
  QUARTERS DIVIDENDS TOO LOW       SKIP(I)    TOTAL DIVIDENDS TO DATE       CUMDV(I)
  FIRM LABOR RATE                  WAGE(I)    ACTUAL LABOR HOURS                THRS
  FRINGE BENEFITS PER HOUR         BNFT(I)    PROBABILITY OF A STRIKE       CHANC(I)
  CURRENT NUMBER OF LABOR SHIFTSSHFTS(I)      PERSONS AVAILABLE PER SHIFT      SSIZE
```

Figure 1. THE IMAGINIT MANAGEMENT GAME Generalized Output Format and FORTRAN Variable Names (decision variables underlined)

```
                       ***UPDATE HISTORIES***
    DO 890 J=1,3
    PRICL(I,J)=PRICE(I,J)
    IF(SHARE(I,J).LE.ZERO) PRICL(I,J) = ZERO
    PRTSL(I,J)=PARTS(I,J)
    CUMRD(I,J) = CUMRD(I,J) + RAD(I,J)
    ADVL(I,J)=ADV(I,J)
890 SMENL(I,J)=SMEN(I,J)
    CUMOR(I)=CUMOR(I)+OPSCH(I)
    SOLD(I,1)=SHARE(I,1)*CVOLA
    SOLD(I,2)=SHARE(I,2)*CVOLA
```

Figure 2. Illustrative IMAGINIT Computer Coding (FORTRAN IV)

(Card No. 11)

Materials lead time

Number of months required after an order is placed before materials can be used for production. Only one outstanding order may exist at a time.

Product A-1: ____________ WAIT(1)

Product A-2: ____________ WAIT(2)

Product B-1: ____________ WAIT(3)

Order preparation cost

The cost added to factory overhead for each new order of raw materials for an individual product.

____________ SETUP

Materials storage cost

Cost per year to store $1000 of raw materials.

____________ HLDRM

Finished goods storage cost

Storage cost per unit per year for finished goods.

____________ HLDFG

Figure 3. Procurement and Storage Parameters Used by the IMAGINIT Model (from the Administrator's Manual)

Table 1
Comparison of Selected Items from Four Versions of THE IMAGINIT MANAGEMENT GAME

Feature, Parameter, or Starting Position	Industry			
	Home Laundry	Tire	Home Climate	Early Television
Market A product	Washers	Autos	Air Cond's	B&W
Market B product	Dryers	Aircraft	Furnaces	Color
--- For the Market A product only ---				
Shipments per firm	100,000	3,000,000	90,000	50,000
Price per unit	$200	$10.20	$400	$75
Materials per unit	$85	$4	$200	$25
Standard labor per unit	10	0.25	25	8.1
Salesmen $ per year	$500,000	$400,000	$600,000	$200,000
Advertising per year	$800,000	$250,000	$300,000	$100,000
Materials lead time (months)	0.5	1.5	2	2
Distribution channel capacity (months of inventory)	2	3	2	2
--- For the entire firm ---				
Hourly labor rate	$3.50	$4.30	$3.50	$2.00
Fringe benefits per hour	$0.35	$0.24	$0.40	$0.10
Materials storage ($/year/ $1000)	$20	$50	$160	$200
Finished unit storage cost per year	$10	$1	$3	$10
Materials ordering cost	$20,000	$2,500	$1,000	$25,000
Factory capacity cost per man-year	$12,000	$100,000	$20,000	$4,000
Capital expansion limit	25%	15%	20%	20%
Annual depreciation	10%	10%	10%	7%
Loss on factory sale	60%	20%	50%	75%
Fixed annual factory overhead	$100,000	$500,000	$240,000	$650,000
Fixed annual administrative overhead	$100,000	$350,000	$350,000	$125,000
Overtime rate	150%	200%	150%	150%
Months strike last	2	1.5	2	1
Short-term interest	12%	12%	10%	15%
Bond interest	9%	8%	6%	6%
Maximum annual factory expansion	20%	12%	20%	35%
Debt % of equity constraint on bond issues	30%	100%	30%	75%
Bond redemption privilege (annual)	5%	5%	5%	10%
Income tax	48%	48%	48%	48%
Quarterly dividend target	$0.25	$0.50	$0.25	$0.15

administrators who do not know FORTRAN. Table 1 contrasts portions of four versions of THE IMAGINIT MANAGEMENT GAME and indicates how parameters and starting values can change to represent different industries.

Now, after almost eight years of development, the IMAGINIT model is highly fine-tuned. Flukes appear only about once a year. Counter measures against beat-the-model strategies by players are built in. A fourth set of manuals, this time for commercial publication, is being written. THE IMAGINIT MANAGEMENT GAME now runs without the writer's personal supervision. After its birth on the Burroughs 205, it has run on a GE 625 and on IBM's 1620, 1410, 7040, and its 360's 30, 40, 50, and 75. The computer program now resides online on a disk on the IBM 360/50 at Texas Tech. A time-sharing implementation has not yet been attempted. Versions to simulate the following industries are being used or are under development:

Breakfast cereals
Home climate
Automobiles
Encyclopedias and textbooks
Paper products
Television
Tires
Home appliances
Washing products
Direct selling cosmetics
Typewriters
Oil industry (discussed in this paper)

Dimensions of Generality

IMAGINIT started out of a game administrator's desire to "customize" a game to his liking. To do this, he learned to be a computer programmer. Because of this experience, the background theme over the years for the evolution of IMAGINIT as a management gaming vehicle has been to create not a management game, but a management game "generator" that does not require a user to become a computer expert. The goal has been to achieve a gaming tool that a user can handily adapt to any variation of:

1. Manufacturing industry to be simulated
2. Starting positions of firms
3. Number of players
4. Backgrounds of players
5. Number of teams
6. Time available for play

7. Size of simulated periods: months, quarters, years

8. Total simulated time to be represented

9. Outside-the-model additions and nuances

Strategies to Achieve Generality

To achieve the generality aspirations listed above, the following strategies, which are now features of the IMAGINIT gaming vehicle, were developed:

1. Use a widely implemented computer language (FORTRAN).
2. Invent variable and parameter names with lasting meanings.
3. Generalize the output format, yet make each application appear unique by "parameterizing" part of textual computer output to identify industry and products simulated.
4. Parameterize "everything" and treat all parameters as input data rather than computer program constants.
5. Generalize a subroutine to simulate behavioral responses, sensitivities, and elasticities.
6. Print all input and selected trace data during a run and print decision values on players' reports.
7. Permit unlimited parallel runs during sessions and unlimited model passes at one computer turnaround.
8. Provide for shifts in length of period simulated from any size to any other size (years, quarters, or months).
9. Reference all parameters and computing of interactions to a single simulated period size (a year) and provide for automatic setting of results to current simulated period size (year, quarter, or month).
10. Provide for equal or unequal starts among firms and for starts from any product combination.
11. Permit computer model complexity to expand or contract by being able to turn features on or off.

12. Provide for human judgments (e.g., grades) to be input data for the computer model in a way that allows added player participation, player-generated verisimilitude, and non-quantitative nuances of human behavior to affect output consequences.

A Challenge to IMAGINIT's Generality

Recently, THE IMAGINIT MANAGEMENT GAME was asked to serve a management development program for an integrated oil company. If the generality aspirations already discussed were a reality, all that would be necessary would be to establish industry parameters, starting positions for individual firms, and name the industry and its products on the one "parameterized" line of text on the computer output pages. This version could then be set to simulate some combination of months, quarters, or years and scheduled to accommodate the real time available for play in the management development program. It soon appeared that verisimilitude could not be maintained without specificity that destroyed some of IMAGINIT's generality features.

The basic problem was the dissimilarity of the IMAGINIT concept of the manufacturing process from the real process of the oil industry. The basic unit on which the IMAGINIT model had been conceived was a unit of product manufactured by putting things together. The oil industry takes something apart. In the take-it-apart oil industry, the basic manufacturing unit is the incoming barrel of crude oil, not the outgoing end products such as gasolines and fuel oils.

Of course, IMAGINIT had never been designed to simulate building or service industries, and it was now clear it was also not designed for take-it-apart industries. This challenge to generality was a reduction in the scope of industries for which IMAGINIT would serve as a management game generator. But this reduction in generality developed out of how industries are characterized, not out of aspects of the art of game and simulation model design. The generality features discussed above do not consider the scope of the model. Therefore, of interest to professional game designers and users is how the generality features held up or were useful when a basic concept of the game model had to be changed.

To assess the success or failure of the generality features, let us review them in light of the application of THE IMAGINIT MANAGEMENT GAME to the oil industry. First, let it be reported that an IMAGINIT OIL INDUSTRY GAME, distinctly different from the "general" IMAGINIT game, is now successfully running. Figure 4 shows an output page from the oil industry game. Compare this with Figure 1 to see what

```
      THE IMAGINIT OIL INDUSTRY         YEAR  7     QUARTER  2       TEAM  1
 A MAN-COMPUTER SIMULATED OIL COMPANY    ----GASOLINE-----
                               MID DISTS   REGULAR   PREMIUM  FUEL OIL    TOTALS
          INCOME STATEMENT       -------   -------   -------   -------   -------
SALES IN BARRELS                2628002.  1661915.   500581.  2961197.  7751694.
REVENUE                        13053286. 10303589.  3459461.  4853725. 31670048.
TBA & M REVENUE                      1060695.         TOTAL REVENUE    32730736.
        COST OF SALES
REFINED PRODUCTS PURCHASED ($)                  0.        0.        0.        0.
COST OF CRUDE                                                          15873684.
REFINERY LABOR ($)                                                       978927.
ADDED COST FEATURE                         263500.    78680.    92750.   434930.
REFINERY MAINT & DEPR                                                   1679455.
OTHER REFINERY COSTS                                                    1072188.
COST OF TBA & M SALES                                                    537348.
TOTAL COST OF PRODUCTS AND TBA & M                                     20576528.
CHANGE IN FINISHED PROD BALANCES ($)       -82071.  -131436.   633286.   419779.
        COST OF SALES                                                  20996304.
        GROSS PROFIT ON SALES                                          11734432.
SALES EFFORT ($)                          2000000.   400000.   500000.  2900000.
ADVERTISING                                850000.   200000.   100000.  1150000.
RESEARCH PROGRAM                           400000.   200000.   300000.   900000.
COST OF INVENTORY EXCESSES                 314280.        0.   691721.  1022839.
MARKETING OPERATIONS                        63153.    19022.    56263.   138438.
MARKETING PLANT MAINT & DEPR                                            2423398.
COST REDUCTION PROGRAM                                                   120000.
EMPLOYEE BENEFITS                                                        700000.
GENERAL ADMINISTRATIVE OVERHEAD                                         5145004.
INTEREST                                                                3573058.
        TOTAL DISTRIBUTION AND GENERAL EXPENSES                        18072720.
        PROFIT BEFORE INCOME TAX                                       -6338288.
        INCOME TAX                                                     -3042377.
        NET EARNINGS                                                   -3295911.
DIVIDENDS TO PARENT               0.      NEW CAPITAL        13000000.
        CHANGE IN PARENTS EQUITY                                        9704089.

                                   BALANCE SHEET
CASH                         8188864.           ACCOUNTS PAYABLE       12365288.
ACCOUNTS RECEIVABLE         20272848.           SHORT-TERM LOANS         227010.
TBA & M INV ($)               673527.           TOTAL NEW CAPITAL     158500000.
BALANCES ($)                23506656.           ORGINAL CAPITAL       100000000.
REFINING PLANT              82293328.           RETAINED EARNINGS      -9410441.
MARKETING PLANT            126746544.           PARENTS EQUITY        249089552.
TOTAL ASSETS               261681760.           LIABILITIES + EQUITY  261681840.
                         PROFITABILITY FACTOR    99.64

     CURRENT POLICY AND ENVIRONMENT           -GASOLINES-    -FUEL OIL-
AVERAGE INDUSTRY PRICES THIS PERIOD              0.159          1.79
CURRENT TOTAL MARKET DEMAND (BBLS)              8558988.     11213984.
                                         -REGULAR-  -PREMIUM-
SHARE OF MARKET THIS PERIOD                  0.194     0.058     0.264
POTENTIAL SHIPMENTS NEXT PERIOD (BBLS)    1699306.   511844.  3050032.  5261181.
PRESENT COMPANY PRICES                       0.150     0.167      1.65
ADDED COST FEATURE ($ PER BBL)               0.155     0.140     0.035
PLANNED PRODUCTS (BBLS)          2628002. 1700000.   562000.  2650000.  7540002.
PRODUCTS MANUFACTURED (BBLS)     2628002. 1699999.   562000.  2650000.  7540000.
FINISHED PRODUCTS BALANCES (BBLS)         3369002.   213526.  6764344. 10346871.
REFINING PLANT CHANGE       -1679455.           MARKETING PLANT CHANGE  5576602.
CRUDE RUN                    7936842.           CRUDE BALANCES (BBLS)   1012045.
LOANS MADE OR REPAID               0.           PROBABILITY OF STRIKE       0.04
QTRS DIVIDENDS TOO LOW             2.           TOTAL DIVS TO DATE     37350000.
```

Figure 4. THE IMAGINIT OIL INDUSTRY GAME Output Format

happened to the generalized output format. How the other generality dimensions and features survived is reported in the following sections.

Dimensions of Generality (Survival)

Of the nine dimensions of generality listed earlier, all of them survived except the first one, which was to simulate any variation of manufacturing industry. The oil industry model omitted the possibility of simulating months, but this was a convenience. Of the remaining dimensions of generality, the completed oil industry game can: vary starting positions of firms; combine players, teams, and backgrounds to order; structure real and simulated time to fit any program; and include unlimited outside-the-model additions and nuances by means of grades on reports, displays, and player presentations that become computer input.

Computer Implementation

The choice of FORTRAN as the computer language with wide implementation served well by enabling (1) model changes to be developed easily from the existing computer program and (2) shifts to less sophisticated levels of the computer language to implement the new program on small computers for world-wide use. Unfortunately, the ease of model adaptation was accomplished with a loss of meaningful names for variables and parameters. The new computer program was developed by using the original FORTRAN names but with changed meanings. To change the names to fit the new meanings would have incurred more debugging time than was available. To create the new model out of old names with new meanings would not have been possible without the parameterization-of-everything feature. Thus, the new computer program was constructed from the old program merely by changing internal FORTRAN statements and by altering the printing format. Unfortunately, a lexicon is now required to read the FORTRAN program itself. The clarity of reading of the original program was lost.

Importance of the Generalized Responsiveness Subroutine

This feature, combined with the printing of all input and the tracing of selected model data, proved its generality by being the means used to maintain an imbalance between competitive products, yet permitting reality-like responses to decision changes for each of these products. The specific problem the generalized responsiveness feature solved was simulation of the relatively low proportion of the total gasoline market held by premium gasolines in interactive competition with regular gasolines. This proportion was adjusted by trial and error setting of two responsiveness parameters from clues provided by the trace data.

In addition, the responsiveness subroutine permitted both overall and item-by-item adjustments in sensitivity so that the oil industry model did not react as severely to players' decisions as versions used in college classrooms, where for teaching purposes increased model sensitivity is sometimes traded off against responsiveness validity. This ability to fine tune the model sensitivities was invaluable during and between game runs for adapting runs to players' backgrounds.

Generality Features That Survived

Most other generality features survived. Parameterization permitted starting position changes after the first pilot run without reprogramming. Multiple model passes at one computer turnaround permitted correction of keypunch errors without holding up the play. Referencing all parameters and interaction computing to the single simulated period size (one year) and the ability to change simulated period size in the middle of a run emphasized concepts to be learned (especially cash flow and the importance of strikes).

The flexibility of starting positions built into the original IMAGINIT model enabled starting the oil industry with a full line of products rather than the usual starting position of one product to which management teams may add others. (In the take-it-apart petroleum manufacturing process, the full line of products comes out at once. Teams cannot sequentially add to their product lines as they can in the put-it-together manufacturing process of the original IMAGINIT model.)

While not yet used, the capacity to provide unequal starts among firms, to run unlimited parallel runs during a session, and to expand or contract model complexity by turning features off and on all remain.

The ability to incorporate human judgments in the form of grades as input data for the model was changed only enough so that the grades related to specific aspects of oil industry manufacturing and marketing to be emphasized in the management development program. This feature continued to serve its original purpose of preventing the play from becoming merely a numbers game with the computer.

Summary

The generality aspirations for THE IMAGINIT MANAGEMENT GAME were to make it a management game generator applicable to any manufacturing process. As a gaming vehicle, the original IMAGINIT implementation when applied to the oil industry did not wholly live up to these aspirations due to differences between manufacturing processes. However, a large number of the generality features not only survived but made possible the adaptation to the oil industry. The final result is that the original IMAGINIT vehicle is still a management game generator, but only for put-it-together manufacturing industries, and the new IMAGINIT OIL INDUSTRY GAME is a management game generator for the take-it-apart petroleum products manufacturing industry.

"TEACHING ECONOMICS WITH COMPETITIVE GAMES"

Martin Shubik
Yale University

TEACHING ECONOMICS WITH COMPETITIVE GAMES

Martin Shubik
Yale University

ABSTRACT

The talk will discuss experiences with a business game designed to reflect basic economic theory of competition among few firms. The game is accompanied with a text discussing the theory. The game is used in conjunction with regular teaching. Hence its purpose is to serve as an aid and clarification of the subject matter. The experience of playing provides the students with a dynamic instance or a "case experience" of material that otherwise is generally presented in an abstract and highly static mode.

"A FINANCIAL MODEL FOR A COMMERCIAL BANK"

Robert P. Beals
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A FINANCIAL PLANNING MODEL FOR A COMMERCIAL BANK[1]

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Introduction

Today the traditional methods of planning are being strained to the ultimate limit as a result of accelerating technological change, rising production and administrative costs, increased governmental control, and mounting competitive pressures. Even under normal conditions planning decisions, as opposed to control decisions, are far more difficult, involve many more factors, and their outcome usually has a more critical effect on the firm. Planning decisions almost always involve commitment of capital, usually irrevocably. Moreover, it is very difficult to evaluate the efficacy of planning decisions. In fact, the effect of adopting one plan in preference to another may be impossible to determine.

One solution to the problem of appraising alternative plans is to adopt a plan, implement it and then evaluate it in operation. The plan is modified, or alternate plans are tested, until the desired objective is achieved. The fallacy of this procedure is quite obvious, in that it is analagous to destructive testing in quality control. Once the plan is placed in execution, the resources are committed and ultimately consumed, and the objective may or may not be tested during the next period but the original problem may have changed completely by this time.

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[1] This paper is based on an unpublished doctoral dissertation: Robert P. Beals; "Determination of Corporate Objectives and Evaluation of Alternative Strategies Through the Use of Simulation Models"; Texas A&M University, College Station, Texas; 1970.

However, if a model, or representation, of the real situation could be developed and expressed in a form suitable for study with the use of a computer, then the alternative long-range plans could be pretested in the model.

A financial planning model was developed through cooperative research with the First National Bank of Saint Paul, Saint Paul, Minnesota and the Bank of A&M, College Station, Texas. The simulation model enables the planner, or a number of competing participants, to test the effect of alternative planning decisions upon balance sheet and income statement items over a five-year planning period. The model is based on the requirements of a commercial bank, but it could be applied to other institutions, such as savings and loan associations or insurance companies, with only minor modifications of the FORTRAN IV computer program.

Development of the Model

The purpose of the financial planning model is to enable management to test the effect over a future time period of alternative "target" growth rates and changing interest rates on items of revenue, expense, and earnings as well as on assets, liabilities, equity and capital reserves. The simulation also projects the following key operating ratios for five years into the future:

1. Return on assets
2. Return on equity
3. Capital to risk assets
4. Capital to total assets
5. Operating expense to operating income
6. Total loans to total deposits
7. Total investment to deposits
8. Increase in total investment
9. Increase in total deposits

A "cash requirement ratio" is included in the model as an additional management control device. The Texas Banking Commission requires that all banks in the state maintain a minimum cash balance in excess of the sum of 15% of total demand (TDD) deposits and 5% of the total time deposits (TTD). The cash requirement ratio (CRR), therefore, is defined as

$$CRR = CASH/(.15\ TDD + .5\ TTD)$$

The other ratios are defined as follows:

Return on assets

$$ROA = EAT/TA$$

Return on equity

$$ROE = EAT/CANDR$$

Capital to risk assets

$$CTORA = CANDR/TEA$$

Capital to total assets

$$CTOTA = CANDR/TA$$

Operating expense to operating income

$$ETOI = TE/TI$$

Total loans to total deposits

$$LTOD = COML + MTGL + INSTL/TD(I)$$

Total investment to total deposits

$$INVTOD = TEA/TD(I)$$

Increase in total investment

$$ITI = TA(I)/TA(I-1)$$

Increase in total deposits

$$ITD = TD(I)/TD(I-1)$$

where

EAT = net earnings after taxes

TA = total assets

CANDR = capital and reserves

TEA = total earning assets

TE = total operating expense

TI = total income

COML = commercial loans

MTGL = mortgage loans

INSTL = installment loans

TD(I) = total deposits in current year

TD(I-1) = total deposits in previous year

The balance sheet output of a sample run of the financial planning model is shown in Table 1. Table 2 displays the income sheet output and Table 3 shows the key operating ratios developed by the model for the base year (1968) and the five planning years (1969 - 1973).

The balance sheet items are computed by the model by applying the target growth rates, as specified by the planner, to the assets and liabilities of the base year. The values of the revenue items for the five-year planning horizon are functions of the projected interest rates. This is also true of such expense classifications as savings deposits interest, savings certificates interest, and certificates of deposit interest. Payroll expense and other operating expense is determined by the application of forecasted annual rates of increase (or decrease).

The financial planning model was programmed in FORTRAN IV and required approximately eighty man-hours to program and debug. Using the WATFOR compiler, the time required for compilation on an IBM System 360/65 is less than five seconds and the execution time for each run is approximately 0.6 seconds.

Operation of the Model

The model is designed for a five-year plan, but the model is operative for any number of years up to and including five. Data cards are prepared for all of the balance sheet items as of December 31st of the base year, or January 1st of the first year of the simulation. A set of cards is also punched for the income and expenses incurred during the base year. Then cards are prepared which specify the growth rates or expected interest rates to be used in the simulation for all of the balance sheet and income statement variables. Figure 1 illustrates the Input Data Sheet which facilitates the specification of planning parameters and serves as the input form for the key punching operation.

The per cent of net earnings (after tax) to be paid out in dividends will also be specified by management for each of the five years of the simulation. Finally, management must predict the expected price/earnings ratio and the number of outstanding shares of stock for the five years of the simulation. This then completes the input preparation.

The simulation model computes the projected values for all of the balance sheet and income statement items for up to five years into the future in accordance with the growth or interest parameters selected by the planning executive. These input parameters are displayed on the right hand side of the computer output sheets (see Tables 1 and 2). For the balance sheet items the growth rate objectives are expressed in per cent increase per year.

The item "additional funds required" at the bottom of the balance sheet simply serves to balance assets and liabilities and capital each year. Note in Table 1 that in January, 1970 the additional funds required are predicted to be $14,800. This means that the combined effect of all the growth rates assumed by the planner was to cause assets to exceed liabilities and capital by less than $15,000. Management could either adjust certain asset growth rates downward or liability growth rates upward in order to reduce the additional funds required to a negligible amount. However, such a degree of precision is not expected nor required in this planning model. It is recommended that the additional funds figure be ignored as long as it is less than 10% of the total liabilities and capital. If it exceeds 10% of liabilities and capital, as in the case of the year 1972 when liabilities and capital exceeded assets by $162,500, replanning should be undertaken to bring assets and liabilities into closer agreement.

Turning now to the income statement, Table 1, it is noted that the majority of the planning parameters are estimates of the interest rates which will be in effect in future years. The exceptions to this are service charges, other income payroll expense, other operating expense, dividends paid, P/E ratio, and outstanding shares. Service charges are expressed as a per cent of individual deposits. In this hypothetical case, the management of the bank has set for itself the goal of reducing the service charge factor to from 4.0 down to 3.0 per cent, presumably through the application of data processing to the accounting functions. Other income, payroll expense, and other operating expense are expressed in terms of the annual increase, in per cent. Dividends paid are expressed as a per cent of net earnings after tax. The price/earnings ratio is expected to rise to 20.0 in 1969 and remain constant for the rest of the years of the simulation. The number of outstanding shares of stock will remain at their present value--44,000. The income tax rate is assumed to be 50% of net earnings in this simulation. Retained earnings are equal to net earnings after tax, less dividends. Earnings per share are found by dividing earnings after tax by outstanding shares. The projected market value of stock is determined by multiplying earnings per share by the price/earnings ratio. The retained earnings are transferred at the end of the year to the capital and reserves account on the balance sheet. For example, by adding the $49,700 retained earnings of 1969 to the value of capital and reserves (1-1-69) $680,000 one obtains the January, 1970 value of capital and reserves--$729,700.

Evaluation of Model

The financial planning model prepares pro forma balance sheets and income statements for five years into the future based on growth objectives and interest estimates furnished by the planning executive. In addition, the model feeds back to management the values of ten key operating ratios for the current year and for the five planning years. On the basis of the selected input parameters, the future financial health of the bank is summarized in Table 3. An analysis of this table reveals that return on assets dips the first two years and then rises gradually in 1971, 1972, and 1973. Return on equity increases spectacularly from 8.38% to 12.76%. Capital to assets and expense to income decline over the planning period which is a healthy sign. In 1971 the cash requirement ratio rises to 1.06 which indicates 6% more cash than is required is being held in the cash account, rather than being used as an earning asset.

In summary, the model gives every indication of performing satisfactorily, in that it appears to reflect the "real world" financial performance of the bank upon which the model was based. To rigorously evaluate the model the simulated results given by the model must be compared to the actual results over a period of years.

Where deviations appear the model must be modified to align it more closely with the "real" situation. This refinement exercise gives the planner a better "feel" for the business of banking, in addition to providing an accurate model which can be used to develop more precise strategic plans.

Conclusion and Recommendations for Future Research

Simulation models have demonstrated the ease with which innumerable "what if" questions can be answered. The financial consequences of alternative plans can be reliably ascertained with the expenditure of but a few seconds of computer time. For larger models, or smaller computers, the time may run into minutes, but still the cost is insignificant when compared to the value of the information now available to the planner. It must be recognized, however, that the design and implementation of a simulation model is a time-consuming and difficult process. The development of a model that can effectively be used for planning in a larger corporation is a monumental task, requiring ten to thirty man years of effort. But the cost of the model, if it is a close approximation of the "real world", should be quickly offset by the financial gains accruing to the firm as a result of more effective planning.

Recommendations for future research pertaining to strategic planning and corporate simulation models fall into the following areas:

1. Stock valuation modeling
2. Current survey of corporate planning
3. "Real world" application of simulation models
4. Real-time and modular approaches to developing and using simulation models
5. Integration of the corporate planning model with the management information system

A majority of the authorities on financial management suggest that the prime objective of the firm is to maximize the wealth of its stockholders, as measured by the market price. But there seems to be no unanimity on what determines the value of a share of stock. If managers knew the factors that influence stock values they would be able to make decisions which would favorably affect those factors and, in turn, result in stock price appreciation. There is certainly a correlation between market price and earnings per share, but there is a more elusive factor, the price-earnings ratio, which seems to be directly influenced by the firm's growth rate. It is suggested that research be undertaken to determine the factors which contribute to a high P/E ratio and use this information to construct a stock valuation model. The model probably would incorporate the effect of dividend policy, growth in sales volume and assets, debt/equity and other operating ratios.

There has not been a comprehensive survey of the "state-of-the-art" of corporate strategic planning. Ewing[2], Steiner[3], and Thompson[4] made studies of limited numbers of firms some six to ten years ago, but a multitude of changes in businesses and their environment has occurred since 1960. Sweet's[5] study of 1964 surveyed only 41 firms and the questionnaire was oriented toward the organization of the planning function. A survey of the techniques of corporate planning presently employed by the major corporations would be most helpful in providing a base for research on those techniques. Further, the study would serve to "cross-pollinate" planning innovations between the researcher and the participating firms and between the individual firms.

It is recommended that research in planning models be conducted in conjunction with companies in the United States to provide the necessary "real world" flavor to the simulation application. The author's experience in working with the Bank of A&M on the financial planning model supports the fact that both parties benefit from the joint research effort. It is predicted that the majority of the invited companies would enthusiastically support cooperating research projects in the field of computer simulation and modeling.

In developing planning simulation models one discovers quite quickly that everything cannot be quantified. The "difficult variables" may be assumed to be constant or may be ignored and omitted from the model in order to render the model "workable."

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[2] David W. Ewing (Editor); "Long-Range Planning for Management", Revised Edition; Harper & Row, Inc., New York; 1964.

[3] George A. Steiner (Editor); "Managerial Long-Range Planning"; McGraw-Hill Book Company, New York; 1963.

[4] S. Thompson; "How Companies Plan", Research Study No. 54; American Management Association, New York; 1962.

[5] F. H. Sweet; "Strategic Planning--A Conceptual Study"; Bureau of Business Research, University of Texas, Austin, Texas; 1964.

The danger is that these simplifying assumptions may also render the model "invalid". In fact, one author has charged that planners often make the universally invalid assumption that the real world is static. It is recommended that work be intensified in the field of "conversational mode" real-time simulation. Such an approach would accelerate the development of the original model and would facilitate the use of the model as a planning tool by providing instantaneous response to the planner's queries. Moreover, variables which cannot be predicted or are inherently subjective could be supplied as needed by the planner. It is quite possible that a whole new discipline, "heuristic planning", may evolve from this intimate man-machine-model relationship.

Finally, the corporate planning model should help bring into being the long-awaited management information system. Computer scientists, systems analysts, programmers and, hopefully executives and line managers, are currently developing the elusive management information system in industry and in the university. It is suggested that the corporate simulation model could serve as the basis for the company management information system. The management information system must encompass the planning function as well as the control function for all levels of management.

The external environment which includes the customer, the government, the investor and the general public, has long been the concern of the planner but has been largely ignored by the systems analyst. The environment, just as much as basic data banks, must be an integral part of a comprehensive management information system.

Through the combination of the efforts of the planner, the modeler, and the systems designer, the integration of planning and control could very well become an accomplished fact. Management will then be able to employ this powerful system to more effectively meet the challenges of the future.

TABLE 1. PROJECTED BALANCE SHEET DATA

FINANCIAL PLANNING MODEL

	BALANCE SHEET					BANK- BANK OF A & M					
	GROWTH RATES SPECIFIED BY MANAGEMENT					BASE	PROJECTIONS (IN THOUSANDS)				
	1969	1970	1971	1972	1973	1-1-69	1-70	1-71	1-72	1-73	1-74
ASSETS											
NON-EARNING ASSETS											
CASH	0.20	0.20	0.20	0.16	0.16	450.0	540.0	648.0	777.6	902.0	1046.3
FIXED ASSETS	0.10	0.10	0.10	0.10	0.10	180.0	198.0	217.8	239.6	263.5	289.9
TOTAL N/E ASSETS						630.0	738.0	865.8	1017.2	1165.6	1336.2
EARNING ASSETS											
COMMERCIAL LOANS	0.10	0.10	0.10	0.10	0.10	2200.0	2420.0	2662.0	2928.2	3221.0	3543.1
MORTGAGE LOANS	0.10	0.10	0.10	0.10	0.10	50.0	55.0	60.5	66.5	73.2	80.5
INSTALLMENT LOANS	0.25	0.25	0.25	0.25	0.25	1250.0	1562.5	1953.1	2441.4	3051.8	3814.7
U.S. SECURITIES	0.10	0.10	0.10	0.10	0.10	880.0	968.0	1064.8	1171.3	1288.4	1417.2
MUNICIPAL BONDS	0.50	0.50	0.20	0.20	0.50	300.0	450.0	675.0	810.0	972.0	1458.0
OTHER BONDS	0.10	0.10	0.10	0.10	0.10	75.0	82.5	90.7	99.8	109.8	120.8
TOTAL EARNING ASSETS						4755.0	5538.0	6506.2	7517.2	8716.2	10434.4
TOTAL ASSETS						5385.0	6276.0	7372.0	8534.4	9881.7	11770.6
LIABILITIES AND CAPITAL											
BANK DEPOSITS	0.05	0.05	0.05	0.05	0.05	250.0	262.5	275.6	289.4	303.9	319.1
INDIVIDUAL DEPOSITS	0.20	0.20	0.20	0.20	0.20	1870.0	2244.0	2692.8	3231.4	3877.6	4653.2
TOTAL DEMAND DEPOSITS						2120.0	2506.5	2968.4	3520.8	4181.5	4972.2
SAVINGS DEPOSITS	0.10	0.10	0.10	0.10	0.10	770.0	847.0	931.7	1024.9	1127.4	1240.1
SAVINGS CERTIFICATES	0.20	0.20	0.20	0.20	0.20	1700.0	2040.0	2448.0	2937.6	3525.1	4230.1
CERTIFICATES OF DEPOSIT	0.20	0.20	0.20	0.20	0.20	115.0	138.0	165.6	198.7	238.5	286.2
TOTAL TIME DEPOSITS						2585.0	3025.0	3545.3	4161.2	4890.9	5756.4
CAPITAL AND RESERVES						680.0	729.7	790.3	870.9	971.8	1101.3
SUB-TOTAL						5385.0	6261.2	7304.1	8552.8	10044.2	11829.9
ADDNL FUNDS REQUIRED						*****	14.8	67.9	-18.4	-162.5	-59.3
TOTAL						5385.0	6276.0	7372.0	8534.4	9881.7	11770.6

TABLE 2. PROJECTED INCOME STATEMENT DATA

	INCOME STATEMENT						BANK- BANK OF A & M				
	INTEREST OR GROWTH RATES* SPECIFIED BY MANAGEMENT					BASE YEAR	PROJECTIONS (IN THOUSANDS)				
	1969	1970	1971	1972	1973	1968	1969	1970	1971	1972	1973
INCOME											
COMMERCIAL LOANS	9.0	9.0	9.0	9.0	9.0	180.0	198.0	217.8	239.6	263.5	289.9
MORTGAGE LOANS	8.0	8.0	8.0	8.0	8.0	4.0	4.0	4.4	4.8	5.3	5.9
INSTALLMENT LOANS	10.0	10.0	10.0	10.0	10.0	105.0	125.0	156.3	195.3	244.1	305.2
U.S. SECURITIES	4.4	4.5	4.6	4.8	5.0	35.0	38.7	43.6	49.0	56.2	64.4
MUNICIPAL BONDS	6.5	6.5	6.5	6.5	6.5	15.0	19.5	29.2	43.9	52.6	63.2
SERVICE CHARGES	4.0	3.7	3.4	3.1	3.0	70.0	74.8	83.0	91.6	100.2	116.3
OTHER INCOME*	0.1	0.1	0.1	0.1	0.1	10.0	11.0	12.1	13.3	14.6	16.1
TOTAL INCOME						419.0	471.0	546.4	637.5	736.7	861.0
EXPENSE											
SAVINGS DEPOSITS INT	4.0	4.0	4.0	4.0	4.0	28.0	30.8	33.9	37.3	41.0	45.1
SAVINGS CERT INTEREST	5.0	5.0	5.0	5.0	5.0	72.0	85.0	102.0	122.4	146.9	176.3
CC INTEREST	5.0	5.0	5.0	5.0	5.0	5.0	5.8	6.9	8.3	9.9	11.9
PAYROLL EXPENSE*	0.2	0.2	0.1	0.1	0.1	80.0	96.0	115.2	126.7	139.4	153.3
OTHER OPERTG EXPENSE*	0.1	0.1	0.1	0.1	0.1	120.0	132.0	145.2	159.7	175.7	193.3
TOTAL EXPENSE						305.0	349.5	403.2	454.4	512.9	579.9
NET EARNING BEFORE TAX						114.0	121.5	143.2	183.1	223.8	281.1
INCOME TAXES ACCRUED						57.0	60.7	71.6	91.5	111.9	140.5
NET EARNINGS AFTER TAX						57.0	60.7	71.6	91.5	111.9	140.5
DIVIDENDS PAID	0.25	0.25	0.25	0.25	0.25	11.0	11.0	11.0	11.0	11.0	11.0
RETAINED EARNINGS						46.0	49.7	60.6	80.5	100.9	129.5
PRICE/EARNINGS RATIO	20.0	20.0	20.0	20.0	20.0	17.8	20.0	20.0	20.0	20.0	20.0
OUTSTANDING SHARES/M	44.0	44.0	44.0	44.0	44.0						
EARNINGS PER SHARE						1.30	1.38	1.63	2.08	2.54	3.19
PROJ MKT VALUE OF STOCK						23.0	27.6	32.5	41.6	50.9	63.9

TABLE 3. PROJECTED OPERATING RATIOS

KEY OPERATING RATIOS

BANK OF A & M

	(PERCENT)					
	1968	1969	1970	1971	1972	1973
RETURN ON ASSETS	1.06	0.97	0.97	1.07	1.13	1.19
RETURN ON EQUITY	8.38	8.32	9.06	10.51	11.51	12.76
CAPITAL TO RISK ASSETS	14.30	13.18	12.15	11.58	11.15	10.55
CAPITAL TO TOTAL ASSETS	12.63	11.63	10.72	10.20	9.83	9.36
OPER EXPENSE TO OPER INCOME	72.79	74.21	73.79	71.28	69.62	67.35
TOTAL LOANS TO TOTAL DEPOSITS	74.39	72.80	71.04	70.94	71.22	69.72
TOTAL INVESTMENT TO DEPOSITS	101.06	99.85	98.85	98.09	97.83	97.80
CASH REQUIREMENT RATIO	1.01	1.02	1.04	1.06	1.03	1.01
INCREASE IN TOTAL INVESTMENT	****	16.5	17.5	15.8	15.8	19.1
INCREASE IN TOTAL DEPOSITS	****	17.6	17.8	17.9	18.1	18.3

INPUT DATA SHEET - FINANCIAL PLANNING MODEL								BANK:							
BASE YEAR:		YEAR 1:			YEAR 5:			PREPARED BY:				DATE:			
BALANCE SHEET DATA								INCOME STATEMENT DATA							
	BASE 1-1-		TARGET GROWTH RATES						BASE YEAR		PROJECTED INTEREST RATES				
			1	2	3	4	5				1	2	3	4	5
CASH		CRI						CLI		CLIR					
F/A		FRI						MLI		MLIR					
COML		CLRI						ILI		ILIR					
MTGL		MLRI						USSI		USSIR					
INSTL		ILRI						MBI		MBIR					
USS		USRI						SCI		SCR					
MUNB		MBRI						OTHII		OIRI*					
OTHB		OBRI						SDI		SDIR					
BANKD		BDRI						CERTI		SCIR					
INDD		IDRI						CDI		CDIR					
SAVD		SBRI						PAY		PAYRI*					
SAVC		SCRI						OOE		OOERI*					
CERTD		CDRI						MVS		CPS**					
CANDR		OUTS**						N		PERATE**					

* Projected Rate of Increase

** Predicted Value

FIGURE 1. INPUT DATA SHEET

"AN ECONOMIC STRATEGY ANALYSIS GAME"

James A. Zwerneman
Research Triangle Institute

GAMING-SIMULATIONS OF ECONOMIC SYSTEMS

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Introduction

It seems quite apparent that in recent years significant strides have been made in our ability to adequately model and represent a great variety of complex organizational and behavioral processes through simulation and related techniques. Even though we have not yet attained a fully acceptable and satisfactory level of development in our model constructions, it appears reasonable to assume that the time is not far off when a number of highly general, precise, and fully validated models of a wide range of system-types will be available for use in policy formulation at several levels.

It has been pointed out, however, that the generation of models simply is not enough. Models must be employed effectively in the decisionmaking process to really justify the resources expended upon their development. Unfortunately, the models are, in many cases, used by persons quite different in nature and experience than those who have developed the models themselves.[1]

Recent theoretical advances in the development of dynamic models, mathematical programming, simulation, and statistical techniques have led simultaneously to improvements in comprehensive data bases and accurate forecasting methodologies. These advances in quantitative analysis, as applied to behavioral as well as technical systems, have not been linked, as effectively as might be desirable, to the decisionmaking process in the formulation of national or lesser governmental policies. This gap, between analyst and policymaker, is no more evident than with respect to the procedures used to stipulate goals for economic-systems' operations.

The specification of public or general societal goals or objectives is never an easy task. Objective functions . . .

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[1] Allan G. Feldt; "Potential Relationships Between Economic Models and Heuristic Gaming Devices"; paper presented at a symposium entitled, "The Role of Economic Models in Policy Formulation"; Office of Emergency Planning, Washington, D. C., October 20-21, 1966, p. 1.

> ". . . need to be based on the preferences of the elected officials and the citizenry . . . . Hopefully, study can provide a rough picture of relative preferences and also some quantitative information on how the marginal trade-offs between objectives change with their level of attainment. Questions of consistency and uniformity of preferences should be studied across individuals and officials.[2]

The fact that the task of identifying goals is difficult offers no justification for rejecting attempts to do so. We, as analysts and practitioners, must concern ourselves with these tasks because those persons who have to make decisions cannot wait until the "science," or the art, of decisionmaking has been perfected. Even when goals are formally stated,

> " . . . it is difficult to determine . . . success or failure because of inadequate . . . definitions and statistical measures and because goals are frequently incompatible and no preference ordering among them can be determined.[3]

Current research efforts are being expended in order to help bridge the gap between analysis and policy, between researcher, and decisionmaker. The techniques being employed in this effort are designed to meet the following objectives:

1. Facilitate an environment whereby policymakers can experience involvement with complex simulation models and systems.

2. Demonstrate how gaming techniques and decision theory concepts can assist in the development of strategies for policy decisions consistent with goals and objectives that can be, in turn, determined by exercising the system.

3. Explore new ways of using computers in an interactive mode for policy purposes.

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[2] Charles C. Holt; "Quantitative Decision Analysis and National Policy: How Can We Bridge the Gap?"; in "Quantitative Planning of Economic Policy"; Bert C. Hickman, ed.; The Brookings Institution, Washington, D.C., 1964, pp. 255-257.

[3] Jack W. Wilson; "An Investigation of Macroeconomic Goals for the United States Economy"; (RM-OU-236-7); Research Triangle Institute, Research Triangle Park, North Carolina, 1967, p. 13.

This paper describes an adaptive modeling procedure that has been used effectively in the development of an economic strategy analysis game. The game, which is currently operational on several computer systems and is being utilized in different heuristic environments, has been relatively successfuly in fulfilling, at least to some degree, the objectives listed above. One reason that helps explain this degree of success can be attributed to the gaming-simulation technique itself which "represents an advance over other traditional aids to resource allocation,"[4] particularly in research efforts that have been directed toward the development of economic decisionmaking and investment planning models.

An Economic Strategy Analysis Game

Current computer technology permits on-line conversational-mode processing of large data bases and complex models; it calls for a different class of models than those designed for batch-processing computers. The Economic Strategy Analysis Game, ESA-1, is an intermediate step, or prototype, in the development of models which fully utilize this computing power and speed. One development in this class of models, referred to as adaptive models, as well as the full specifications of the ESA-1 Game, is the result of recent research efforts.[5]

The game provides the basis for analyzing strategies employed by players relative to stated objective functions or player-modified preferences. The introduction of exogenous events and information systems provides a basis for performing decision analyses and allows players to test alternative strategies. The gaming-simulation may also provide insight into the decisionmaking process by analyzing the information requests of the players and their reactions to particular situations.

The game involves a procedure of adaptive modeling which synthesizes the empirical results, provided by core econometric models of economic systems, with the more abstract developments of decision analysis.

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[4] Robert M. Ranner and Wilbur A. Steger; "Simulation and Long-Range Planning for Resource Allocation"; in "Quarterly Journal of Economics," Vol. LXXVI, May 1962, p. 240.

[5] A. H. Packer and J. A. Zwerneman; "An Economic Strategy Analysis Game"; (RM-OU-236-10); Research Triangle Institute, Research Triangle Park, North Carolina, 1969.

The advantages and limitations of the decision-theoretic approach can be illustrated as follows. The state-of-the-world, either a macro- or micro-economic system, is defined by a set of uncontrollable variables $\{x\} = X$. The decisionmaker will be able to control a set of instruments $\{y\} = Y$. A decision determines the value for any y; a plan is a set of decisions which establishes the value for the entire set Y. Alternative world states or plans will be indicated by a superscript, i.e., X^i or Y^j; subscripts will denote the time period, and an underline will indicate a sequence beginning at time t=0 and continuing until time t; e.g., $\underline{X}_t$. The planning period extends from t=0 to t=T. The decision theory problem is:

$$\text{Maximize:} \qquad \Phi = \Phi(\underline{X}_t, \underline{Y}_t) \tag{1}$$

$$\text{Subject to:} \qquad X_{t+1} = G_t(X_t, Y_t, u_t) \tag{2}$$

where, in the adaptive case, a priori knowledge of certain relevant probability distributions (but not of u) is typically assumed for all t.

If the constrained maximization problem can be solved explicitly, the solution will provide:

1. The optimum strategy (or strategies in the case of multiple optima). Thus, there is no need to enter into a search process.

2. An evaluation of the shadow prices of each of the constraints.

3. A loss function that measures the suboptimality of suboptimal decisions and thus determines the value of information.

4. An evaluation of flexibility within the concept of an optimum first period decision and optimum contingent future decisions based on alternative information sets.

The limitations of the decision-theoretic approach are:

1. The difficulty of obtaining an acceptable objective function.

2. The restrictions which must be placed on the form of Φ and G in order to obtain a solution explicitly.

3. The unreasonable assumptions--discussed below--about the a priori knowledge of the relevant probability distributions.

The advantages of econometric model building are: that the three limitations noted above are avoided, that the results are based upon empirical data, and that the knowledge is provided in concrete terms (for example, fiscal and monetary multipliers) which are immediately meaningful to decisionmakers. Adaptive modeling attempts to gain some of the advantages of the several approaches even though some of the vigor is dissipated in the heuristic procedure.

The Procedures of Adaptive Modeling

The most essential characteristics of adaptive models are:

1. Their primary purpose is to aid in the development of strategies in situations in which planners are faced with the problem of dynamic decisionmaking under uncertainity.
2. Their subject matter is complex socioeconomic systems for which objectives cannot be easily stated.
3. The subject system is characterized by considerable uncertainty of two types; first, the relationships among the system's variables are not perfectly known and, second, random exogenous events are extremely important to system performance.
4. The models are structured to represent the actual decisionmaking environment as realistically as possible and to take maximum advantage of the principles of decision analysis.
5. The models are intended to be modified and extended as they are used. Further, the models are not restricted to empirically derived relationships but may include expert judgment concerning imperfectly known parameters and relationships. However, the model's conclusions must be empirically testable.
6. The models are designed to facilitate interaction between the users and the model. The most efficient way of accomplishing this will generally be to use computers in a conversational mode, i.e., to practice man-machine simulation.
7. Adaptive models will usually have the first five, and perhaps all seven of the following components; a primary model, a definition of the roles of decisionmakers, an objective function, an information system, a means of simulating a dynamic decision process, a library of exogenous events, and a set of auxiliary models.

The primary model will be formal, that is, explicitly stated so that a computer program can be written to solve it. The primary model in ESA-1 is a modified Wharton-EFU model.[6] Some additional notation is required. Denote the primary model F and divide the set X into two subsets; denote the variables endogenous to the primary model X^{**} and those exogenous or predetermined X^{*}. Further, divide the set Y into two subsets; denote the variables exogenous to the primary model Y^{*} and those which do not appear in the primary model Y^{**}. Finally, denote the parameters of the primary model as Π. The primary model F will provide conditional estimates of the state-of-the-world X^{c} given specific values for the set of exogenous and predetermined variables X_t^{*}, and the set of instruments Y_t^{*};

$$\therefore X_{t+1}^{c} = F\ (\Pi | X_t^{*},\ Y_t^{*}). \tag{3}$$

The roles of decisionmakers are defined in terms of their instruments (including the constraints they may face in manipulating the instruments), their transformation function, and their objective function. The general case of joint decisionmaking is considered here. In this situation each of the decisionmakers is responsible for a subset of instruments. Thus, the set of instruments is divided in a number of not necessarily exclusive subsets:

$$\{y^{a}\}\ \{y^{b}\}\ \cdot\ \cdot\ \cdot\ \{y^{r}\} = Y. \tag{4}$$

Each decisionmaker deals with some abstraction of the reality; i.e., the economic system. This abstraction, the decisionmaker's transformation function, will contain the primary model described above and may also contain one or more auxiliary models as described below. In addition to the formal models there will usually be an informal part of the transformation function; this is the individual's subjective concepts which he uses in his decisionmaking process. Each decisionmaker may have his own objective function, Φ^{a}, Φ^{b}, . . . , Φ^{r}, and his own transformation function, G^{a}, G^{b}, . . ., G^{r}. These latter possibilities will not be considered in the following discussion (i.e., all decisionmakers will be assumed to have a single objective and transformation function).

The objective function evaluates conjunctions of alternative world-states X^{i} and executed plans Y^{j}. In the static or single period case:

$$\Phi_t = \Phi(X_t^{i},\ Y_t^{j}). \tag{5}$$

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[6] The Wharton-Econometric Forecasting Unit is described in Michael K. Evans and Lawrence R. Klein; "The Wharton Econometric Forecasting Model"; University of Pennsylvania, Philadelphia, Pennsylvania, 1967.

For the dynamic or multiperiod situation, it is identical to equation (1) discussed earlier, and shown below:

$$\Phi = \Phi(\underline{X}_t^i, \underline{Y}_t^i). \tag{1}$$

The information systems provides $I = \{F, H, \underline{R}_t\}$ where F is the primary model, H is the set of auxiliary models, and $\underline{R}_t$ are reports. The decisionmaker's information may include conditional forecasts based on the primary and auxiliary models and reports on the performance of the system during the simulated period and on the possibility or occurrence of exogenous events.

Conversational mode computing capacity provides the means of simulating the dynamic decision process. The decisionmakers need only develop plans one period at a time on the basis of information received the previous period.

The library of exogenous events contains the set of possible shocks E which the economy may face in a simulation run, e.g., an international conflict of various types and magnitudes. A sequence of reports R(E) will be associated with the possibility of occurrence of each event E. The shocks may be called from the library in response to a monitor or referee, or by a random number generator.

The final component of the adaptive modeling process is the set of auxiliary models H; these connect the primary model with the outside world or, more exactly, that part of the economic system which is not explicitly represented in the primary model. Three categories of auxiliary models can be identified depending upon the part of the outside world with which they deal.

The first category links the primary model with the exogenous events previously discussed. In general, these events and their associated reports affect either the exogenous variables or the error terms of the primary model. Denote the exogenous event category of auxiliary model as f'; then

$$(x^*, u) = f' \, [R(E)]. \tag{6}$$

For example, if the primary model contains a dummy variable x^*_{ss} whose value is one or zero depending on whether or not a rail strike is in progress, then the (very simple) auxiliary model would be:

$x^*_{ss} = 1$ if rail strike is in progress

$x^*_{ss} = 0$ if rail strike is not in progress.

The second category of auxiliary models links the primary model with instruments which are available to the decisionmaker but which have not been included in the primary model. For example, the Wharton-

EFU model contains free reserves in the banking system as an exogenous variable; however, open-market operations of the Federal Reserve Board are not represented. For ESA-1 an auxiliary model defines a relationship between open market operations and net free reserves. Denote the omitted-instrument category of auxiliary model as f", then

$$x^* = f''(Y^{**}) \tag{7}$$

where x* are exogenous variables of the primary model (such as free reserves) and Y^{**} are instruments omitted in the primary model.

It is generally true that whatever the level of aggregation in the primary model, decisionmakers will at some time be interested in specifics that are only visible in a more disaggregated model. If the primary model is of the macro-economic type, the performance of specific sectors, such as housing or steel, will, at some time, enter the decisionmaker's objective function (e.g., he will be interested in balanced performance or balanced growth). If endogenous variables of the primary model are the explanatory variables in the auxiliary model, then the axuiliary model is referred to as disaggregating, is denoted g, and gives values of W excluded from the primary model as functions of the endogenous primary model variable;

$$W = g(X^{**}). \tag{8}$$

ESA-1 contains the components described above, i.e., a primary model, decisionmaker roles, an objective function, an information system, a dynamic process, a library of exogenous events and the auxiliary models. The standard output includes aggregate levels of consumption, investment, employment, prices, wage rates, factor shares, changes in interest rates and the public debt, industrial capacity, and exports and imports.

ESA-1 is designed for four players: A monetary authority player and three players with fiscal responsibilities representing the Treasury Department, the Defense Department, and all other federal departments combined. Fiscal decisionmakers have seven policy instruments at their disposal. The monetary player has three policy instruments that he can use to influence the output of the economy. A series of exogenous shocks can be introduced into the gaming environment by the referee. This permits a high degree of realism as well as new measures of uncertainty against which the players must react. The policyplayers are scored on the value of a number of economic indicators at the conclusion of each time period of play; they receive penalties, representing the political administrative costs of policy implementation, whenever certain policy instruments are altered and receive end-of-play bonuses or penalties for the average rate of absolute changes and indicators over the simulated period. The forms of the scoring equations are asymetric quadratic functions of deviations from target values, except for prices where a parabolic function is used. A comprehensive information system, that has been designed with player strategies in mind, permits the players to test alternative policies and forecast results before actual decisions are made.

Playing the Game

When the initial values for the variables and instruments have been created, the ESA-1 is ready to play. The following specifies the steps to be taken during each successive round of play:

1. The players receive the output, generated by the computer, listing the current values for the select variables.
2. The referee may announce an exogenous shock to the economy. He may announce this with certainty, subject to a known probability distribution, or in some inexact manner (e.g., "In the opinion of the Secretary of Defense, the war will be over within six months.").
3. The players may ask (via console input) for additional information relating to any data generated by the model over the last eight periods or for the selected annual data for the last five years; the requests may include any simple arithmetic manipulation of the data.
4. The players may ask for conditional forecasts. That is, they may estimate the impact of the shock announced by the referee upon the primary model variables, change (temporarily) those variables accordingly, and ask for the resulting solution of the composite model. The referee may restrict the policyplayers to a limited number, say three, forecasts.
5. The players make their "moves" for the current period's play of the game by typing the policy variables code names and their values at the console.
6. The referee provides the appropriate input variables, i.e., shock parameters, to the auxiliary shock models by typing the variable code names and their numerical values at the remote console. The auxiliary model subroutine calculates values of the appropriate variables which are affected by the shock under consideration. These values are subsequently used to solve the game's primary model.
7. The referee must also specify values for the remaining exogenous variables.
8. The referee initiates the solutions of the primary model. The model is solved for the values of its endogenous

variables; thus indicating the response of the economy to both the shock and the player's moves for the time period being simulated.

9. The results indicate the new state of economic system; the standard printout is provided to the players who then evaluate the data and additional information and prepare for the sequential time period.

Conclusion

This paper briefly described an Economic Strategy Analysis Game. The objective is not a recreational or educational game but a procedure which can be employed by decisionmakers in developing the strategies of economic policy. ESA-1 has been demonstrated to economic policymakers, used by students of econometrics, and has been used in the development and requirement of a dynamic and operational adaptive modeling process.

The emphasis on gaming concepts is not necessary to the adaptive modeling procedure. However, it does provide certain opportunities. One is to use the game in an experimental manner to induce the implicit objective functions of the players. A second is to experiment with alternative information systems or alternative organization of responsibilities. A third is to use the game in an operational manner in which individuals replace certain behavioral functions. However, the primary goal is decision analysis and the development of an aid to the decisionmaking process.

The economic policyplayers, assuming roles of fiscal and monetary decisionmakers, and the game referee, who introduces exogenous changes to the economic system, provide a degree of realism. This realism is generally lacking, as are the conditions of uncertainty, when an econometric model is run through periods of time in a stable environment. Repeated successive runs of such a model, allowing for changes in both input data and parameters, can certainly produce alternative forecasts, but the decision analysis is missing.

This does not minimize the necessity for adequate primary models; the results generated by the model must be realistic and accurate enough to provide for a challenging gaming situation and to support real decisionmaking. ESA-1 employs a much-used and well-tested primary model. The additional gaming requirements are achieved through the use of auxiliary models. The players, who take over the functions of some of the actors in the decisionmaking process, are able to play against a recognizable environment which includes realistic relationships.

The adaptive modeling technique may be evaluated in terms of the following:

1. The adaptive process is a gimmick (interesting or not) and the procedure adds nothing of importance to the use of economic models.

2. Adaptive modeling may serve a useful purpose in an educational setting as a supplement to, or partial replacement of, traditional courses; or as a training device for potential administrators.

3. The procedure points the way to more efficient use of econometric models; the efficiency arising primarily from the computer technology (rapid turn around, more efficient communication, time-sharing) and not the decision-analysis framework. Additional gains may be achieved by enhancing the communication between economists and those decisionmakers unfamiliar with economic models.

4. The procedure accomplishes the objectives initially set out--that of bringing the power of decision analysis (which is real and not only a theoretical construct) to bear upon the real problems of economic decisionmaking.

The hope, of course, is that step 4, and steps 2 and 3 as well, can be achieved. If the evaluation is that the fourth step is not achieved, it may further be asked if the critic feels the procedure does not effectively wed decision analysis to econometrics or if decision analysis has little meaning in practical situations. Of course, the ultimate answers to these questions will be found in the empirical evidence associated with the use (or non-use) of the suggested procedure by decisionmakers or their staffs.

"A SOCIAL SIMULATION STRATEGY FOR RESEARCHING THE ISRAELI-ARAB CONFLICT"

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A SOCIAL SIMULATION STRATEGY FOR RESEARCHING THE ISRAELI-ARAB CONFLICT

(an abstract)

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Social simulation strategy seems particularily appropriate to research in the Israeli-Arab conflict when one considers how little opportunity exists in conventional research methods to appraise the situation before it actually occurs, coupled with potentiality to stop the blind process of competition between collectivities from taking its toll. Typical assessments offer a show-down of one kind or another (Sharabi, 1969) or protracted and irreconcilable positions (eg. Harkabi, 1968).

It could be argued that in this type of conflict the structural properties of the simulation should induce:

1) articulation of superordinate goals (following Sherif, et al);

2) exploration of new resources, different use of available resources, and articulation of new bases for exchange (somewhat following Boulding's idea of an integrative system to replace organized order by threat systems);

3) deliniation of certain patterns of association and disassociation policies resulting in a higher potential for peace (following Galtung's conceptualization of rank-dependent international interaction);

4) extraction of the conditions of awareness of the other party and an approach toward optimal empathy with it (in very much a precise active negation of what Hammond refers to as "rapid proliferation into self-contained systems of thought");

5). the shaping and learning of winning strategies. By this we mean a somewhat more complex understanding of the term "strategy" than is meant by Schild and Inbar. For example, game participants would have to contrive or perceive contingencies as well as to select between various aspects of the game.

The suggested strategy utilizes an average of 80 hours from approximately 80 participants spread over a period of a month and a half. Within this period the actual game is played twice. Players assume diametrically opposed roles and each prepares a working document in which they sensitize as well as compile the best available data on their countries and on the personality involved. It has been found that this frame of reference maximizes the simulation pay-off.

A model of the game is supplied. Various characteristics of the game account for special conduciveness for the mentioned research directions. For example, this particular game contains (1) a random profile of information in excess of requested information, so that participants may experiment with data not conventionally understood to be relevant, (2) a Peace Specialist group that frequently proposes peace-oriented strategies to parties, and (3) opportunities for coalition formation that is required to be different from block formation, but which is at the same time absolutely open to any form of experimentation with new allies.

In addition to the general scenario which for each game is somewhat more that the sum-total of all the working documents, input events at the very start of the game and again at about the mid-point shape a special kind of psychological predisposition and are the only times that the simulation control group intervenes. For each role in the game there is at least one validator who operates very much like the INS. An extremely low record of validation for a specific goal may result in replacing the role-player with the validator.

This strategy has been run three times, primarily at the University of Michigan, and has demonstrated a need for a much more sensitized level of research. It appeared in two games that the Middle East compet between the Big Powers, especially as the role of People's China became more salient, induced the parties to the Israeli-Arab conflict to reconsider their stands vis a vis the major powers in light of a new set of potential hazards. In these games, internal processes in Egypt (change of government) and a take-over of Jordan by al Fatah (guerrila group I) leads to some receptivity of the idea of a loose political unification which seems plausible to Israel's leadership as a devise to put an end to manipulation by the major powers. In spite of excoriation inside and outside Israel, a unification takes place which involves some concessions to the refugees and the simulation ends with an outstandingly low level of tension and hostility.

This in turn exemplifies the need to research (1) China's future capability of influence in the Middle East (ideologically, politically, economically etc.); (2) the possible influence of China, the Soviet Union and the United States on "regional" politics; (3) prospects for a "regional" unity transcending the Israeli-Arab conflict; (4) possible changes in leadership within certain time boundaries; (5) conceptions of the "hazards" of war and the willingness to pay their toll of inability to use natural resources optimally; and (6) the interaction of the above.

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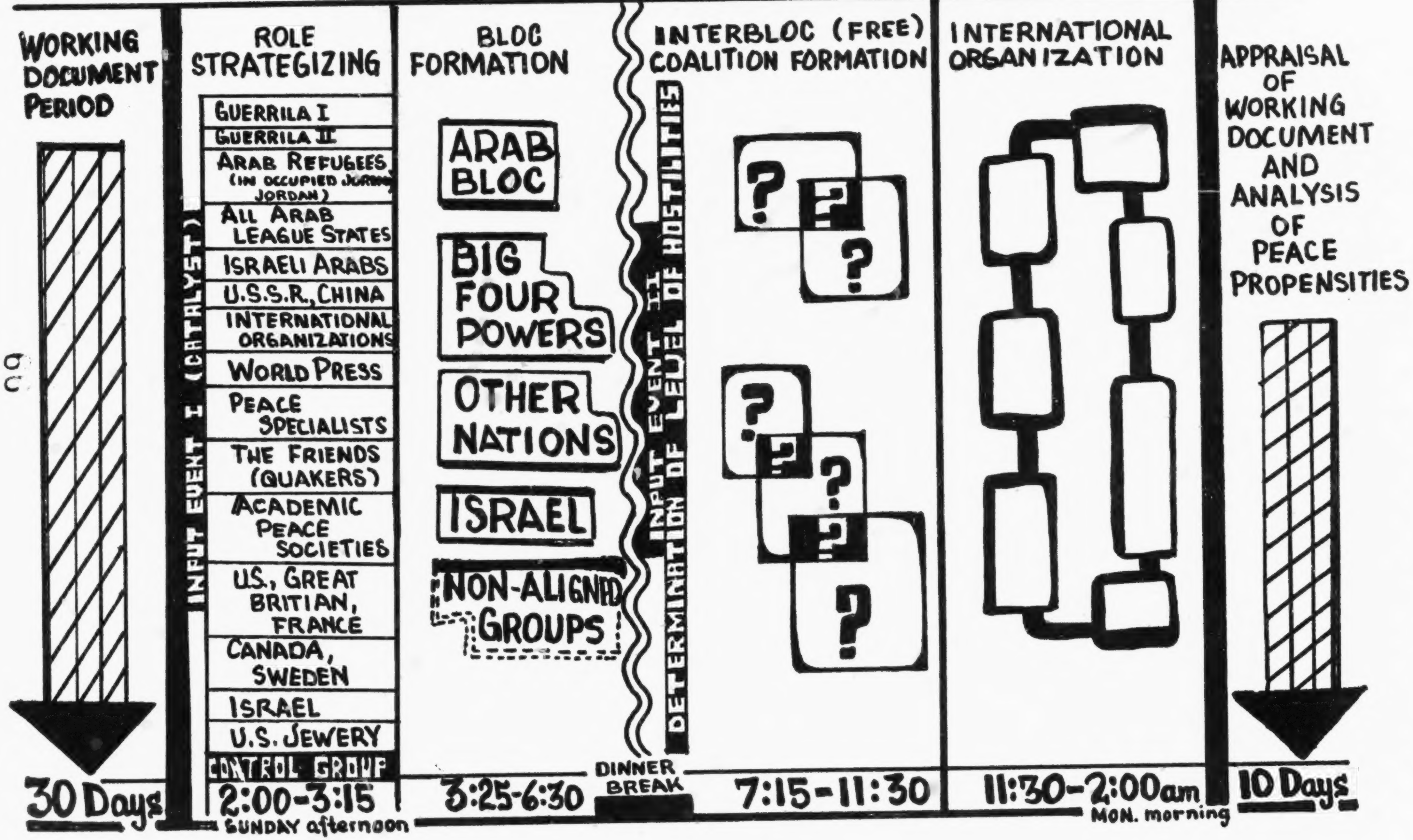
MODEL OF SOCIAL SIMULATION STRATEGY FOR THE ARAB-ISRAELI CONFLICT


WORKING DOCUMENT PERIOD
30 Days
INPUT EVENT I (CATALYST)
ROLE STRATEGIZING
GUERRILA I
GUERRILA II
ARAB REFUGEES (IN OCCUPIED JORDAN JORDAN)
ALL ARAB LEAGUE STATES
ISRAELI ARABS
U.S.S.R., CHINA
INTERNATIONAL ORGANIZATIONS
WORLD PRESS
PEACE SPECIALISTS
THE FRIENDS (QUAKERS)
ACADEMIC PEACE SOCIETIES
U.S., GREAT BRITIAN, FRANCE
CANADA, SWEDEN
ISRAEL
U.S. JEWERY
CONTROL GROUP
2:00-3:15
SUNDAY afternoon
BLOC FORMATION
ARAB BLOC
BIG FOUR POWERS
OTHER NATIONS
ISRAEL
NON-ALIGNED GROUPS
3:25-6:30
DINNER BREAK
INPUT EVENT II
DETERMINATION OF LEVEL OF HOSTILITIES
INTERBLOC (FREE) COALITION FORMATION
?
?
?
?
?
?
?
?
7:15-11:30
INTERNATIONAL ORGANIZATION
11:30-2:00am
MON. morning
APPRAISAL OF WORKING DOCUMENT AND ANALYSIS OF PEACE PROPENSITIES
10 Days

"LOW-LEVEL GAMING IN A COMMUNITY EMERGENCY OPERATIONS SYSTEMS DEVELOPMENT CONTEXT"

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LOW-LEVEL GAMING

In a Community Emergency Operations Systems Development Context
Design and Execution

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Abstract

Two specific gaming techniques are subjected to a critical analysis of their utility and inter-relationship in the solution of actual problems associated with the development of an emergency operations capability at community level. These are Community Response Game (a nuclear attack version of Community Disaster) and Emergency Operations Simulation (a simulation-based training tool aimed at increasing the direction and control capability of local government emergency operations personnel). Particular emphasis is placed on experimental approaches being applied to the evolutionary development of better "briefcase" games.

Introduction

J. Coleman advised me (13 March) that our theme is "Abstraction versus realism . . ." and I take issue immediately! I prefer $A \cap R$, where A is abstraction and R is realism. What bothered me was the word versus and its either/or connotation. We probably agree that games are models of conflict, but let's not have "armed camps" when we approach the problem of game design; rather: boldness $\cap$ judgement, necessity $\cap$ sufficiency.

I am not a professional "gamer." I have, however, participated in a number of "gaming" experiences, analyzed several large and small, computer-assisted and manual, military, socio-economic, and behavioral simulations; and I do engage in the usual games people play.[1] But then, I have never designed a game, so I am not really a "gamer."

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[1] Berne, Eric; "Games People Play"; New York, Grove Press; 1964.

Hence, I now run the risk of learning that: (1) I really don't know enough about "gaming" to be playing the "game" at hand or (2) I have not devised a new approach to game design or (3) both. But, no matter, for I will still have experienced what to me has been "to see or tell some new thing."[2]

An underlying motivation for this project is the several recent indications that better "briefcase" games are needed.[3] A more pressing motivation is a "need" expressed by my boss, to the effect that the principal "gaming" tool used by the Office of Civil Defense, Emergency Operations Simulation Training (EOST)[4] could probably stand some simplification.

Approach

The elegance (and frequent elusiveness) of necessity and sufficiency should probably be applied to all stages of human endeavor; at least, I intend to apply it here.

A first question, then, is: has someone else already, at least, tried to solve this problem?[5] Investigation showed that Community Response Game (CRG),[6] at least, fulfilled two requirements: CRG was and is a "briefcase" game, and it is simpler than EOST. However, as would be expected, CRG had certain less than adequate "behavioral" characteristics, as will be described shortly. The thought then occurred: why not take CRG and EOST and "converge" in a logical fashion on the desired product, which we shall call, for the moment, Civil Defense Operational Game (CDOG)?[7] Now, how to do this?

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[2] Hildebrand, Joel H.; "To Tell or Hear Some New Thing"; American Scientist; March 1963.

[3] "Proceedings, National Gaming Council"; Eighth Symposium; BAAR, Inc., June 1969.

[4] "Emergency Operations Simulation Training", SM 4.1.1 (Operations Manual) and SM 4.1.2 (Simulation Manual), DoD, Office of Civil Defense, January 1967.

[5] Polya, G.; "How to Solve It"; Princeton, New Jersey; Princeton University Press, 1945.

[6] Community Response Game, "Administrators Manual." Designed by Academic Games Associates (for the Office of Civil Defense); published by The Simulmatics Corp.; manufactured by SMG, Inc., 1966.

[7] with acronymic apologies to the proponent of the Army's Combat Developments Objectives Guide!

Design Goals

Next, we had better establish more precisely just what we are trying to accomplish. The author assumes that the interested reader will resort to the references (particularly 4 and 6) for background details. As it turns out, a good first approximation of desired goals is as follows: playing time 4 hours; preparation time 2 hours (administrator only); roles (players) to be all those found in EOST; playing board to be a generalized "map" of the "typical" community of 10,000 to 25,000 with a "tailored" option whereby the actual local map, if converted to "playing board" scale can be used; number of players 5 to 12; emergency operations context: trans-attack, but open-ended (both ends) for possible accommodation of pre-attack, post attack, and other (natural and man-made) disaster operational/decision making play; educational/professional level: 12 years or better "formal" education and 2 years professional (local government) role experience or equivalent; information formats: card decks (situations, problems, events, payoffs, penalties), 2" x 2" slides and/or 8" x 10" transparencies; playing board (per above), control board, audio tape; size and shape: to fit into a normal attache' case; playing environment: two conference tables (one for operations analysis, one for decision makers) and one small table for the administrator, all these in any quiet room, or, optionally in the local community's Emergency Operating Center;[8] supporting equipment (at most): 1-35 mm projector or overhead projector, 3 3/4 i.p.s. tape recorder, pencils, grease pencils (black, red, yellow, green) and paper.

An important design goal that should be mentioned separately is that the game must reflect, on a sampling basis, the entire scope of Civil Defense operations at local community level as reflected in current published material.[9]

Realism is to be introduced by resorting to a variety of results of research "extro-spection" in this area, for example, one or more exercise scenarios that already exist,[10] and currently espoused

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[8] "Emergency Operating Centers, manual for the development of", MP-38; Department of Defense, Office of Civil Defense; July 1966.

[9] "Publications Index", MP-20, Department of Defense, Office of Civil Defense; March 1969.

[10] e.g., "Civil Defense Exercise Situation Library", Final Report-STEP; System Development Corporation; 4 October 1965.

70

techniques of damage assessment[11] and "patterns" of expected weapon lay-down (from recent Civil Defense exercises).

Game Re-design Theory

We like to have an orderly approach. I have seen several manuals on exercise - simulation - games. I have not seen a simple theory of how one might go about game re-design. Hence, I offer the following:

Let $G = (A, B, \ldots, N\text{-}1, N)$, a finite group[12] of games; where:

(Composition) (1) If $A * B = C$, then $C \subset G$; $*$ is a general operator.
(Associativity) (2) $A * (B * C) = (A * B) * C$
(Identity) (3) $A * I = A$, and $I * A = A$, and $I \subset G$
(Reversibility) (4) $A * A' = I$ where $A' =$ inverse of A

Of course, this kind of abstraction may raise the hue-and-cry of impracticability; alternatively, the challenge is to derive the necessary and sufficient characteristics of the set of operators (*), in consideration of practicality and realism. And, there is one more reason for this approach. That is, Piaget's remarkable theory[13] of the origins of intellect employs the group concept as an orderly approach to cognitive learning. Since we are dealing with learning, training, or teaching games, what better base for a re-design technique?

Re-design Technique

One first determines the group of games in which one wishes to "imbed" CDOG. For example, some review of prior research and development and use of "gaming" by the Office of Civil Defense yields a group as follows:

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[11] "Damage Effects Estimation Techniques" MP-44; Department of Defense, Office of Civil Defense; February 1967. (currently under modification).

[12] Keyser, C. J.; "Mathematical Philosophy, a Study of Fate and Freedom"; New York; 1922.

[13] Flavell, J. H.; "The Developmental Psychology of Jean Piaget"; Van Nostrand, New Jersey; 1963.

G = (..., CRG, ..., EOST, ..., CDEX[14]-Series, ...)[15]

One then proceeds to apply "operational rule" (1) above to one or more members of the group, to yield CDOG; rules (2), (3), and (4) are attempted, but do not apply as easily as in the case of a number system. That is, they help, but can be omitted as long as the primary "group property," (1), is met.[12]

In what follows, I will describe progress to date and two "feedback" techniques that are to be used to "validity-test" the end-product.

Role Conversion

Since games are primarily for players, role conversion seems to be a logical starting point, remembering that game objectives are already established as: those of EOST. In addition, the "roles" to be "played" are fairly definitive in both CRG and EOST. So, why not start with what appears to be a fairly simple (trivial, I hope not) trial of the application of the group-theoretic approach described above?

CRG provides for 16 roles (policeman, fireman, public works employee, emergency operations coordinator, "I am sick" (a sick person), manager of telephone company, radio operator, emergency operations volunteer, Red Cross official, public utilities official, business executive, newspaper reporter, wife/hospital volunteer, volunteer nurse, TV station owner, and Janitor/part-time ambulance driver).

We shall halt here for the moment to discuss design/re-design philosophy(?).

Design Philosophies

There appear to be several useful game design approaches:

A - Start from "scratch."
B - Take an existing game or set of games and:

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14. Civil Defense Exercise - (date), a series of nationally run exercises, defense oriented "war games." While a "higher-level" game than EOST, one of our boundaries, CDEX is included as a "source" as mentioned above (target patterns).

15. Finite, but no need to be exhaustive here.

1. Derive re-design criteria by having a group of "experts" play the existing game(s) under controlled conditions; obtain "feed back;" then apply these criteria. (Pre-delphic?).

2. Derive re-design criteria through individual analysis of the existing game(s); apply these criteria; then have a group of "experts" play the "new" game and "feed back" desirable modification. (Post-delphic?).

C - Other approaches (computer-based re-design, random trials and eventual convergence on desired product, etc.).

Both B-1. and B-2. appeal to me, with B-1. preferred. The A approach appears uneconomical (at least wasteful of available talent). Approach C, "random trials . . ." also appears wasteful, though used; and computer-based re-design is appealing, but will probably require further development of approach B-1. (or perhaps this is already being done?).

Role Conversion (continued)

The problem, now, is to devise the operators (*) to get from 16 not-very-professional (with a few exceptions) roles to the 12 (at most) desired roles (of EOST) to be incorporated in CDOG. One does this by considering that *, as appropriate (art versus science!), may consist of: (+, -, x, ÷) in a quantitative sense and ($\cap$, U) in a qualitative/quantitative sense. Additionally, one can look upon raising or lowering educational level as $\int \frac{d}{dR}$ or $\frac{d}{dR} f(R)$, and transformation of one role into another similar role as a kind of multi-dimensional (attribute-wise) vector transformation. The important point is: I believe that to at least attempt the precision associated with these mathematical operators, even with some judicious subjective choice of "factors" thrown in, will tend to yield a fairly elegant solution. Obviously B-2. is less noisy than B-1., but perhaps one can teach the "experts" to think this way!

In any event, since as of this writing, B-1. has not been officially accomplished, I can only state that B-2. has been applied and the result is the role - set on the right, with original roles on the left:

CRG Roles	(*)	CDOG Roles[4]
Business Executive	→	Chief Executive
Emergency Operations Coordinator	→	CD Director and Military Liaison
Public Utilities Official	→	Operations Group Chief(& Resources)
Emergency Operations Volunteer	→	Disaster Analysis Group Chief
Manager of Telephone Company Radio Operator	→	Message Controller (Communications Officer)
TV Station Owner	→	Public Information Officer
Newspaper Reporter	→	Shelter Operations Section
Policeman	→	Police Operations Section
Fireman	→	Fire Operations Section
Public Works Employee	→	Public Works and Engineering Operations Section
Wife/Hospital Volunteer Volunteer Nurse	→	Medical and Health Operations Section
Red Cross Official	→	Welfare Operations Section
"I am Sick"	→	(None)
Janitor/Ambulance Driver	→	(None)

It will be interesting to see how the "role conversion" comes out using approach B-1. Of course, one must hope that none of the subjects will have had access to the above!

Continuing the Design

The remainder of this paper will (very briefly) outline re-design tasks yet to be accomplished by the researcher, and the approaches to be used.

Events/Problems/Tasks

Perhaps the two most important things to keep in mind when addressing the events/problems/tasks "decks" task are: time budget and credibility (realism). As cited above, there has been so much research on the latter that I do not believe we have to worry about it too much. The challenging problem will be: to keep the players busy . . . to partition the available events data so that each player experiences that "sense of urgency" that is associated with emergency situations (the battalion or company-level military defense problem is a case in point).

We will start with a large set (a lesser group) of situation material[10] and "operate" upon it in a rather precise fashion. Our operator (*) must now have the following capabilities: (f(t), ÷, +, -, x, series, relational, inter-relational, inclusive, exclusive). Of these, several may require explanation.

The chosen, or transformed, events must, in toto, converge (in a series-sense) on an eventual "solution;" that is, after 4 hours of intensive group interaction[16] one would hope that the players will have the feeling that they just experienced a rather nasty situation and that they were able to keep it rather well in hand! That is not to say that the inverse, divergence,[17] is not an equally valuable approach; rather, that the players are more likely to be motivated if exposed to a controllable situation.

Each set of role-related events must "relate" to each other set if the group is to be "exercised" as a group rather than as individuals. On the other hand, simultaneity (and non-simultaneity) must be considered, to be realistic. That is, some randomness, some time delay, would be appropriate so the players can be exposed to the "search-for-relationships" problem.

Finally(?), a "comfortable" set of events must be included, but enough important events must be excluded, to yield a set which teaches the group how to perform when lacking complete sets of data (deduction, inference, probability, uncertainty, "where is the enemy," etc.).

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[16] Berne, Eric; "Principles of Group Treatment"; New York; Oxford University Press; 1966.

[17] Maruyama, Magoroh; "Morphogenesis and Morphostasis"; Methodos, Vol. XII, No. 48; 1960; Milano; also "The Second Cybernetics . . .," American Scientist, Vol. 51, No. 2; June 1963.

Work along the above lines is now underway. A later paper may describe the outcome. Similar techniques are to be applied to the "playing board", educational level, and the balance of the things that have to be done to achieve the design goals.

Conclusion, for the Moment

An emergency operation (like music) is essentially an experience. Explanation, analyses, and all similar aids to understanding are of value only so far as they facilitate that experience and its retention in memory.

Since the emergency conditions that might result from nuclear attack cannot be experienced until the event occurs, any useful practice of the art of organized response to such a massive emergency can only be carried out through tests, exercises, simulations, games, or similar techniques.

The Civil Defense Operational Game is being developed in this context, and in the manner outlined above. One hopes that all this can be, also, fitted into a briefcase. I believe it can, and still achieve a comfortable balance between abstraction and realism.[18]

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[18] But what is reality? (author).

"THE USE OF SIMULATION GAMES IN INSTRUCTION"

Jerry H. Fletcher
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THE USE OF SIMULATION GAMES IN INSTRUCTION

Jerry Fletcher
John Adams High School

ABSTRACT

One of the weakest points of the use of games in the classroom is that the participants in the game are the ones who are supposed to do all the learning; whereas, when games are used as a part of serious research, it is clearly the observers of the participants who do the serious learning, in the sense that they test their theories about that particular social situation. It is possible to establish situations in high school classrooms where students are involved in deliberately setting up a certain kind of social situation, running participants through it and carefully observing their behavior in an effort to test sociological theories. Social science simulation games provide a unique opportunity to have students take theories which are read about in books and put them to a direct test. This paper presents a rationale for such an approach to using games in instruction.

"SIMULATION IN HIGH SCHOOL GEOGRAPHY"

Angus M. Gunn
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SIMULATION IN HIGH SCHOOL GEOGRAPHY

Angus M. Gunn

In geographic education simulations take their place as part of a long tradition of simplifying the human environment for study, a tradition that has recently received a new impetus both from the use of models and simulations for research and from the development of simulations and simulation games for the classroom.[1] Nowhere have these new developments for the geography classroom been more in evidence than in the High School Geography Project. This paper accordingly focuses on some aspects of this Project.

The High School Geography Project spans a decade of unprecedented curriculum activity in the United States. It began in 1961 as a joint endeavor of the National Council for Geographic Education and the Association of American Geographers. By 1964 it had moved entirely under the wing of the Association of American Geographers, and had become the recipient of greatly enlarged financial support via the National Science Foundation. By the Spring of 1970, when the last unit was published commercially, two and a half million dollars had been spent in the nine-year task of producing a brand-new, one-year high school geography course.[2]

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[1] R.J. Chorley and P. Haggett (eds); "Models in Geography"; Methuen, London, 1966

Paul A. Twelker (ed); "Instructional Simulation Systems, An Annotated Bibliography"; Continuing Education Publications, Oregon, 1969

[2] The following books, most of which are now out of print, together with 17 newsletters issued between 1962 and 1969 give a comprehensive view of the work of the Project.

1962: "Advisory Paper"

1963: "Response Paper"

1964: "Selected Classroom Experiences"

Massive federal funding was the prime mover which brought the scholar out of research into education. It was not just the attraction of dollars. Money was the expression of a whole new climate which followed, or preceded in one or two cases, the flight of sputnik. Even high school students felt the impact of the new priority. Competing for grades became as fashionable as competing for a place on the football team. It was in the wake of this recovery of respectability for education that scholars and particularly geographers were attracted to education.

Young, for the most part unknown geographers who had ideas and who were willing to work were given freedom to develop new and exciting materials for HSGP (High School Geography Project). Their terms of reference were set by a steering committee representing the profession nationally. These terms of reference were broad. They allowed the innovator to experiment freely, to enlist his own educational advisors, and to try out his materials informally in some local school. The result was a range of new materials, materials which captured the interest of high school students. The output of

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[2] 1965: "Fresh Water Resources", TG
"Fresh Water Resources", SR
"Introduction to the Course"
"Geography of Cities", TG
"Geography of Cities", SR
"Structure of Geography"

1966: "Introduction", SR
"Introduction", TG
"Inside the City", SR
"Inside the City", TG
"Settlement Theme Course Outline"
"Network of Cities", TG
"Network of Cities", SR
"Manufacturing", SR
"Manufacturing", TG
"Political Processes", SR
"Political Processes", TG

1967: "Demonstration Kit"
"Introduction", TG
"Introduction", SR
"The Growth of Cities", SR
"The Growth of Cities", TG
"Habitat", SR
"Habitat", TG

scholars working in different parts of the country was coordinated in a Project office which also conducted trials on a wider basis, and arranged for commercial publication of the complete one-year course.[3]

With the exception of major equipment like film and overhead projectors, everything needed for the classroom is provided--student manuals, decks of role cards, activity sheets, overhead transparencies, and hardware models. Each lesson of the 200 or so in the whole course carries detailed suggestions for classroom organization and procedures. Typical of these suggestions are open-ended inquiry questions which focus on materials rather than on people, questions for which there are no "correct" answers. In addition, the materials of the course are divided into six units to facilitate scheduling in schools. Each unit is further subdivided into five or six activities each of which constitutes one week's lessons.

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[2] 1968: "The Geography of Culture Change", SR
"The Geography of Culture Change", TG
"Agriculture", SR
"Agriculture", TG
"Japan", SR
"Japan", TG
"Geography of Cities", SR
"Geography of Cities", TG
"Manufacturing and Agriculture", SR
"Manufacturing and Agriculture", TG
"Cultural Geography", SR
"Cultural Geography", TG
"Growth of Cities", Evaluation Report
"Geography of Culture Change", Evaluation Report

TG: Teacher's Guide
SR: Student Resources

[3] The following are a few samples from the many articles by unit authors, Steering Committee members, and Project staff.

Gilbert F. White; "A Joint Effort to Improve High School Geography"; "Journal of Geography"; November, 1961

Nicholas Helburn; "High School Geography and What is being about it"; "Social Education"; December, 1966

Dana G. Kurfman; "Improving the New Geography through Evaluation"; "Bulletin of the National Association of Secondary School Principals"; February, 1967

HSGP Simulations

In the final course materials there are sixteen well-defined simulations with several others included as parts of case studies of particular places. These simulations are distributed as follows within the units.

1. Geography of Cities: Site diagrams, Portsville, City shape, Time-distance

2. Manufacturing and Agriculture: Metfab (US), Metfab (USSR) Game of Farming, Industrial location

3. Cultural Geography: Games illustrating the spread of ideas, Expansion of Islam

4. Political Geography: Section, One Man One Vote, Point Roberts, School Districts

5. Habitat and Resources: Flood Hazards, Rutile and the Beach

Site Diagrams

Five maps of hypothetical places are presented to the students with the question, "which of four sites is the most desirable for present settlement and future growth?" Each map represents a different type of location, and each carries a different date. The same question is asked in relation to each map and the students, in groups, make decisions and support them in open discussion.

City Shape

Five geometrical forms of city shapes are provided. In each the original site of the city is marked by a black dot, and two subsequent growth areas are outlined representing the first and second fifty years of history. Students are asked to say which patterns are most reasonable, and then are asked to suggest conditions under which these reasonable patterns would emerge.

Time Distance

A map of a hypothetical city is marked off by a network of time distances which link together five points within the city. Students are required to find a point which is more accessible than any other to all of the city's population. One definition of the central business district is thereby secured. A new highway introduces a change in the network by changing several time distances. The students then calculate the new point of maximum accessibility.

Metfab (U.S.)

Students form management teams in order to decide on the location of a new factory "Metfab". Each team consists of a president, a sales manager, a production and purchasing officer, a personnel manager, and a treasurer. To simplify the choice of location it is decided to locate the factory in one of the twenty-five largest metropolitan areas of the United States. When the decisions are made each choice is defended in a class debate.

Metfab (U.S.S.R.)

This is a repeat of the previous simulation except that the location factors change. Some of the new considerations are: all industry is owned and operated by the government; all major decisions about an industry are made in Moscow; decisions are handed down from the top level via a Council of Ministers to a State Planning Commission and thence to the particular industry's department in one of the national ministries.

Industrial location

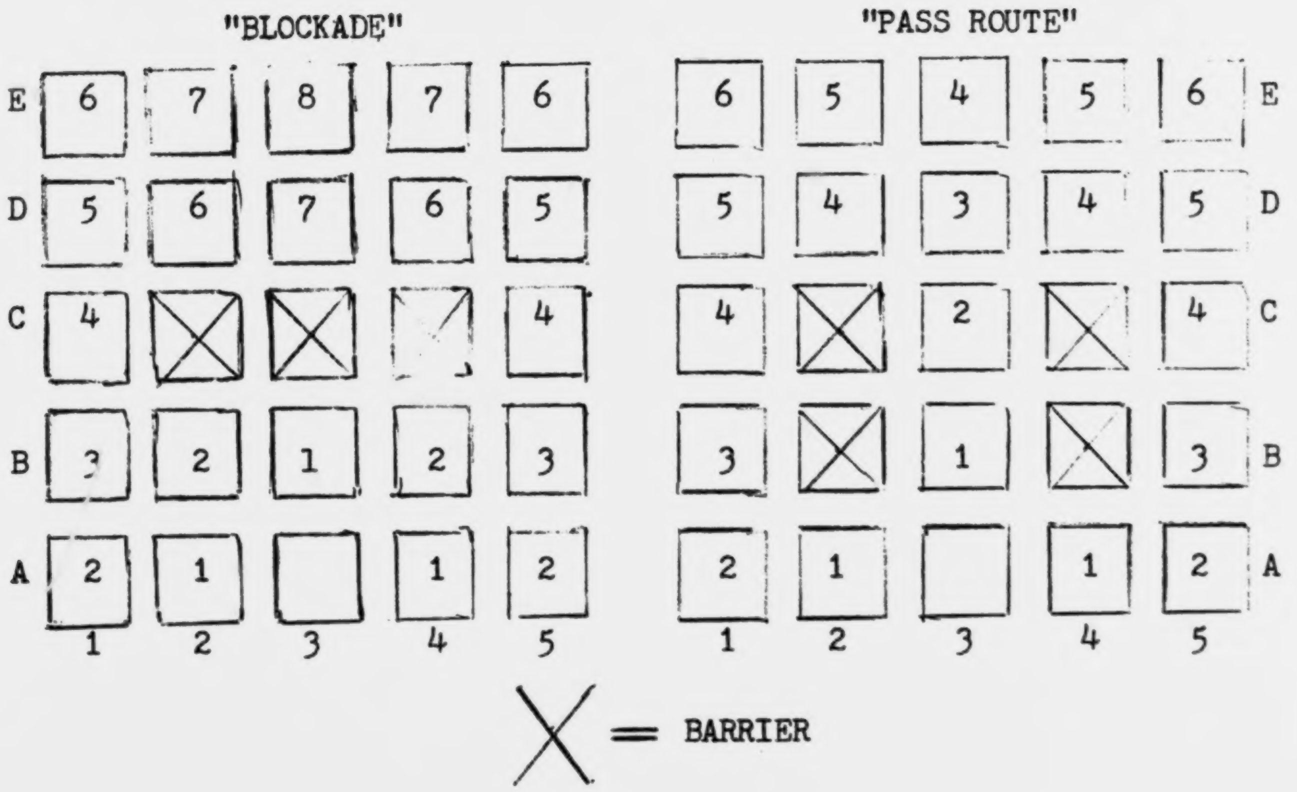
Students create their own simulations of nine major industries by representing in a graphical way the dominant locational factors at work. The strength of the "pull" of any one factor is indicated by the size of the symbol used to represent that factor. The class works in small groups with each group examining a different industry. Final simulations are presented to the class by group representatives.

Games illustrating the spread of ideas

The classroom constitutes the simulation in this activity, and the differential movement of information within the classroom represents the spread of ideas. Because of its extreme simplicity and therefore its general utility one aspect of this simulation is detailed below. The activity as a whole simulates the processes by which ideas and information spread from person to person, and from nation to nation.

Expansion of Islam

Students, with the help of several pages of narrative, map and seek to explain the historic course of the spread of Islam. The simulation takes the form of a student-designed model based upon consideration of the following parameters: what were the core ideas of Islam? Where did it originate? Where did it spread? How long did it take? Was it continuous or did it skip over some areas? How was it spread? What obstacles did it encounter? Did it change in the course of being spread?



"BLOCKADE"

E	6	7	8	7	6
D	5	6	7	6	5
C	4	X	X	X	4
B	3	2	1	2	3
A	2	1		1	2
	1	2	3	4	5

"PASS ROUTE"

6	5	4	5	6	E
5	4	3	4	5	D
4	X	2	X	4	C
3	X	1	X	3	B
2	1		1	2	A
1	2	3	4	5	

X = BARRIER

BLOCKADE - PASS ROUTE (Note: answers included here)

Purpose: This excercise lets you see how different barriers affect the flow of information in an area.

Instructions

1. Use box A-3 as your starting point on each of the above maps, "Blockade" and "Pass Route". Decide which boxes A-3 can reach by the rules of the game, which are the same as those you have already used in class--that the idea can move only one box at a time and at right angles, not diagonally and not by skipping. The idea cannot pass over or through any barrier (X).

2. Write the number 1 in all the boxes A-3 can reach under the rules, number 2 in all the boxes the 1's can reach and so on until all the blanks on both maps are filled except those containing an X. No numbers are allowed in the X boxes.

3. Draw a line that marks the front edge (boundary) of all your 1's, then a line marking the boundary of your 2's, and complete the map with similar lines for each number.

4. Write the highest number that appears on each map.

Section

Students take the roles of citizens of a hypothetical state, Midland, which is divided into five sections - a capital - Centerville, an agricultural section, a growing industrial section, a declining industrial section, and an economically underdeveloped rural section. As teams, students debate the disposition of a state budget in relation to a variety of needs within each of these five sections. The game is concluded with a discussion of the processes experienced.

One Man One Vote

A 1900 map of a hypothetical state, Orillia, shows that in 1900 eligible voters were equally represented in terms of number per representative. By the present time, however, major inequalities have emerged. Students are therefore faced with the task of redrawing the boundaries of each representative's district to correct the various imbalances. End discussion focuses on the fact that equal representation may be accomplished in more than one way, and that some ways favor one political party at the expense of others.

Point Roberts

An international boundary dispute based on the Point Roberts enclave in Washington State is the setting for this role-play simulation. A problem is created by the arbitrary closing of the boundary by the Canadian Government. Students role play as members of an International Joint Commission which seeks to find ways of reopening the border.

School Districts

This is a role-play simulation which is similar to "one man one vote" except that the issue is the boundary of a high school. Students examine maps of a hypothetical neighborhood in which a new high school is being built, and come up with recommendations on a desirable set of boundaries to encompass the "catchment" area of the school.

Flood Hazards

The various options open to citizens for preventing floods form the structure for this activity. Data, based on real conditions in a Western Pennsylvania community, point up the nature of the dangers to be faced in the event of another flood. Students in groups choose and defend one of the seven options, or adjustments, which are available. No one of these adjustments gives complete protection from all of the dangers.

Rutile and the Beach

Three conflicting interests are found in some areas along the southeastern coast of Australia - beach mining of rutile minerals, surfing, and conservation of native fauna and flora. This simulation points up the ways in which these three interests conflict, and the ways in which they share common interests. Students are asked to decide the issue of a mining licence in the light of these different interests.

Because of the special significance of two of the HSGP simulations, "Portsville" and "Game of Farming", more descriptive information is provided for them than for the other fourteen. The special significance will become clear in the section on school trials.

Portsville

A modulex board is the focus of this simulation. Students place small pieces of colored materials on an outline site map of a hypothetical west coast city which sprang up in 1850. Four boards are used in a class, and each group of students builds its own city using the colored materials, or lego blocks, to indicate their land use decisions. At first the period 1850-1880 is reconstructed. Students use a historical reading and a set of historical photographs to help them. The second part of the reconstruction covers 1880-1900. An evaluative discussion concludes the ten lesson sequence. Students are encouraged to defend the layout of the city they have created, in the knowledge that there is no one right layout. The teacher's role throughout is that of an observer-asking why choices have been made or pointing out some of the difficulties implicit in some of the choices.

Game of Farming

Students role-play as immigrants who have just arrived in Western Kansas in 1880, and are beginning to farm there. They are given a small amount of money and a quarter section of land, and then asked to decide, on the basis of their previous experience, what stock or crops they will rear or grow in the crop year 1880-81. There is no information on previous farming experience in the area. At the end of the crop year students are given weather and other data which determine the success or failure of the year's farming. The crop year 1881-82 is planned in the light of the previous year's experience. Similarly for 1882-3. A second cycle of farming is played out for 1919-21, and a third cycle for 1933-35. The 1880-82 cycle demonstrates the effects of natural conditions, the 1919-21 cycle the effects of war-time economic fluctuations, and the 1933-35 cycle the double effects of the world-wide economic depression and the conditions which led to the "dust-bowl" tragedy.

School Trials

The 1968-69 school trials were more extensive than any previous ones, and they dealt with manuscripts that were very close to the final versions which were published commercially. Twenty-nine teachers from twenty-two states were selected. Twenty-six of them were in public schools. They were above average in teaching experience and in their understanding of geography. Approximately one thousand students were involved and they were distributed as follows: one third ninth graders, one quarter tenth graders, one quarter twelfth graders, and one sixth eleventh graders. They too were above average in terms of verbal aptitude. Test items, teacher questionnaires, and student questionnaires all featured in the evaluation instruments.

Unfortunately these trials were carried out on half only of the HSGP course materials. Cut-backs in funding in the latter part of 1968 severely curtailed trials to the point where the results on the second half of the course were not worth recording. The comments and statistics quoted below therefore refer to the content, including the simulations, of the following three units only: Geography of Cities, Manufacturing and Agriculture, Cultural Geography.

On a four point scale on which 4.0 was highest, the following information was secured on simulation activities versus all other activities.

	8 Simulation Activities	15 Non Simulation Activities	Portsville and Game of Farming
Teacher Interest (average)	3.58	3.48	3.95
Teacher Estimate of Worth (average)	3.34	3.16	3.86
Student Interest (average)	3.13	2.91	3.66
Student Estimate of Worth(average)	3.05	2.92	3.33

Portsville and Game of Farming consistently ranked as the top two items on each of the four lists and teacher comments, a few of which are quoted below, leave no doubt as to the general success of these particular simulations. The first two quotes refer to the Game of Farming, the others to Portsville.

"The game is so much fun it is easy to lose sight of its objectives"

"It was great! It generated more excitement than anything I ever witnessed in a classroom"

"I have rarely enjoyed teaching anything as much in my entire life"

"There was equal enthusiasm in both my high and low ability classes"

Values and Trends

The developmental histories of simulations like Portsville and Game of Farming support many of the hunches about simulations which have flooded the literature. The realistic union of scholarship and teaching is one of these hunches. A simulation can, at the same time, be a vehicle for social theory and a medium for teaching sociological insights.[4] Other hunches relate to empathy and understanding. Empathy is heightened by the high involvement demanded. The real-life penalties of mistakes are realistically experienced. The role of chance in real life is better understood.

For geographic education one of the fundamental advantages is the bridge between the real world and our theoretical constructs which are derived from reality. Direct study of the environment by the inexperienced usually fails to secure the kind of clear thinking necessary for simulation decision-making. The jungle of sights and sounds hides its secrets. Yet decision-making expertise is an essential component of the present social studies emphasis on social action.

There are two other equally significant values for geographic education, the chance of a stake in tomorrow's educational world, and a greatly increased measure of student interest. For some time there has been a growing uneasiness that geography, like history, has an almost exclusive pre-occupation with the past. In a world of accelerating change this was bound to become a matter of concern. Simulations provide the needed vehicle to free geography from time constraints, and to enable it to postulate future environments.

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[4] James S. Coleman; "Games as Vehicles for Social Theory"; "American Behavioral Scientist"; July-August, 1969

Student interest is always a challenge to an educator. If a student is intensely interested in learning he will work harder, remember longer, and make better use of what he has learned. The long-standing interest of young people in role-playing, the freedom from direct teacher control for a large part of a lesson, the opportunity to learn from peers instead of adults - a mode of learning which is frequently underestimated - and the challenge of an unknown outcome all are found in simulations, and all help to increase student interest.

The central role of the student in any educational endeavor is a high priority of our times. It is one which needs to be stressed in relation to educational simulations. These simulations are means to an end, not ends in themselves, and the end is decision-making citizens in the real life situations of tomorrow. The question must be asked at the conclusion of every simulation, how real are these situations to the students? In post-game class discussions, students' experiences with simulations must be compared with their perceptions of the reality being simulated, and subsequent simulations re-designed in the light of these discussions.

We can expect high school geography simulations to increase in number and in complexity. The increasing pressure for reform in classroom organization, together with the emerging wave of materials from national social science curriculum projects are trends which support the classroom use of simulations. The Foreign Policy Association was probably right when it said of simulations two years ago, "We are in the beginning stages of a movement, not a technique."[5]

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5. "New Dimensions; Simulation Games for Social Studies Classrooms" Vol 1, No 1, Foreign Policy Association, 1968

"THE CAROLINA POPULATION CENTER FAMILY PLANNING POLICY GAME"

Thomas H. Naylor, Arnold H. Packer, and R. Scott Moreland
University of Wisconsin

A FAMILY PLANNING POLICY GAME

by

Thomas H. Naylor
R. Scott Moreland
Arnold H. Packer

Carolina Population Center

The irrational use of human reproductive powers now profoundly influences the welfare of mankind. Many demographers, economists and political leaders have addressed themselves to the world population problem in recent years, and the Secretary General of the United Nations has stated that "the population problem must be recognized as a principal element in long range national planning if governments are to achieve their economic goals and fulfill the aspirations of their people."

In response to this crisis situation, millions of dollars are going to be spent by private and governmental organizations on population planning during the next few years. Although there is a general agreement that large amounts of money must be spent to help different countries to develop and implement sounder demogenic policies, there is much less agreement on how to go about achieving this goal. There is an urgent need for more systematic approaches for designing, implementing and evaluating alternative population planning policies and programs, in order to visualize and to choose wisely among possible ways to achieve both short run goals of reducing population growth rates and long run goals of increasing levels of socioeconomic development.

Policy makers and administrators are increasingly seeking answers to such questions as the following: (1) What effect, if any, will a particular population planning policy have on population growth, per capita income, and other socioeconomic variables for a given country or a region? Is a particular policy consistent with other national goals of the country? (2) Given a set of socioeconomic goals for a country or a region, what types of population planning policies and programs are likely to be "optimal" - that is, most consistent with these goals? What are the tradeoffs between expenditures for population planning and expenditures for education, agricultural development, etc.? (3) Given a specific population policy direction, how can the process of program organization and implementation most efficiently proceed at national, regional and local levels?

The relevance of systems analysis concepts to population planning as a means of obtaining operational solutions to problems of the type described above is now becoming increasingly apparent. If population planning is to proceed in an orderly fashion, policy makers will ultimately be forced to turn to systems analysis in view of the complexity and sense of urgency associated with the population problem. Indeed, the question is not whether to apply systems analysis or not, but whether to apply systems analysis effectively or ineffectively.

In this paper we describe the application of a particular tool of systems analysis to population planning, namely computer gaming. The Systems Analysis Program of the Carolina Population Center has recently developed a family planning policy game for training administrators of family planning programs in underdeveloped countries. This game is based on the organizational structure of a prototype family planning program for a typical underdeveloped country. The organizational structure for the family planning program is characterized by three different decision levels - national, regional and district. One person is assumed to be in charge of the entire national family planning program for the prototype country. His role is to allocate the funds which he receives from outside agencies and his own government to the various regions of the hypothetical country. The various regional directors must then allocate their funds among four or five districts which are areas with populations equal to about one million. Each region consists of various districts and there are the same number and types of districts in each region. For example, region one may be composed of an urban center, a farming area, a rural community, and a coastal fishing area. Each of these would be a different district within the region and contain the same population and environmental parameters. Region two might be similarly composed so that the performance of players can easily be compared. District family planning directors make decisions on how they will spend their budgets within their own districts.

The decisions which are made by the individual players are then read into the computer along with certain information describing the environment to be simulated by the computer. The computer then generates the response of the population of the hypothetical country to the family planning program which the players have chosen to implement. The results of each period of play are then printed out by the computer. The game may be repeated for as many periods as are desired. Each time period is assumed to be equal to one year.

The model underlying this game attempts to simulate the demand and supply conditions for family planning services in an underdeveloped country. The players (or decision makers) of the game make two general resource allocation decisions: demand creating decisions and supply (or capacity) creating decisions. The output variables of the game which measure the performance of the players include contraceptors, births, births averted, and cost per averted birth.

The total demand for a particular contraceptive method during time period t is derived from two sources: (1) the number of non-contraceptors undertaking the particular contraceptive method for the first time in time period t and (2) the number of contraceptors using some other method in the preceding period who have switched to the particular method in question during time period t. The demand for family planning services from the first source is a function of a set of policy decisions and a set of environmental parameters. The policy decisions in the demand equation are resources allocated to various functions during time period t to generate demand and were identified for us by family planning experts. These policy variables include expenditures for field staff training, field staff recruitment, field staff supervision, field work salaries, mass media promotion, target population identification and reporting efforts, and post-partem use of hospitals and facilities. The exogenous factors include per capita income, average family size, infant mortality rate, number of fertile women who work, number of fertile women (15-40 age group), activity rate of fertile women, and a stochastic error term. The demand from the second source, i.e., people switching their contraceptive method, is computed using a Markov chain probability matrix.

Turning to the supply side of the picture, in order to accommodate the total demand, the capacity to deliver a particular contraceptive method to a particular location during a given time period must be available. This may be achieved by the creation of new capacity, utilization of existing capacity, or additions to existing capacities. Allocations are made by the players to manpower facilities, supplies, and transport accommodations to any or all of three types of delivery systems: hospitals, clinics, or temporary camps. There are, therefore, a total of twelve different budget decisions concerning capacity creation.

The realized demand is then calculated as the difference between total demand and the demand on the part of disappointed contraceptors (those whose demand for contraceptive services is not satisfied because of capacity limitations). The model calculates the number of births during time period t as a function of the number of contraceptors in the preceeding period and the relative effectiveness of the contraceptives. Once the model computes the number of births, it is a straight-forward process to update the total population and to calculate the birth rate for the particular period. The model also calculates a projection of births and computes the number of births averted due to contraception and the cost per prevented birth. The exogenous variables of the model are assumed to follow a simple exponential trend pattern.

A complete description of the game (including instructions for the administrator of the game and the players, a complete specification of the model, the computer program, and sample output) can be obtained by writing to the authors at the Carolina Population Center in Chapel Hill, North Carolina.

During the summer of 1970 the game will be tested by the Chinese Center for International Training in Family Planning in Taichung, Taiwan.

"ECONOMICS OF THE ENVIRONMENT DECISION MODEL: A FIRST STEP"

James J. Sullivan
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AN ECONOMICS OF THE ENVIRONMENT DECISION MODEL: A FIRST STEP

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Assistant Professor
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Introduction

It has become exceedingly essential to provide the background for and training in the decision processes necessary to achieve an optimal relationship between the components of our total environment. For concerned citizens to demand an end to pollution is to demand the ideal. To achieve the ideal may be so expensive in terms of resource use that health and education programs may seriously suffer. Those concerned about the environment must be made aware of the consequences of their decisions. They need to understand that an extra dollar of resources allocated to pollution control or elimination is not efficiently allocated if the social benefit that accrues is less than one dollar.

Therefore, the economic consequences of a proposed solution, the decision processes used, and analysis of the system itself become of central concern to achieve not the ideal environment but the optimal balance between the components of the environment.

The purpose of this paper, then, is to report on a simulation game designed to measure the economic judgment of students (or others) about the economic impacts of a community development plan. It is a first step in developing an economics of ecology decision model. A second, but not secondary goal, is the training of students to analyze such problems. Finally, once the model is sufficiently developed it can be used to deduce the impact of changes in its structure on the outcomes.

The remainder of the paper is divided into two basic sections:

1. The General Decision Framework. This section contains a discussion of the overall complex problem of developing and utilizing a decision model for the total environment.

2. The Simulation Game. In this section the "process to be simulated", the planning model, roles, the play of the game, and the elements to be considered in the Cost/Benefit model are discussed.

The General Decision Framework

It is difficult enough to establish the concepts and organize the elements of the natural environment. But this task is small when one attempts to conceptualize and organize the many environments in which we live. Furthermore, to enumerate the elements that comprise each "sub-environment" and the attributes by which we describe those elements (past, present, and future state) adds to the problem. Additionally, once we have the concepts organized, the elements identified and measured, we must still determine the outcome of various actions that affect the environmental balance.

We need a model that will allow us to solve for the impact of various private or public actions on the various environments. Given these impacts we then need to use them as input into the decision process. Are these outcomes acceptable in general or only within a particular set of circumstances? We therefore need the goals or priorities (national, regional, or local as the problem dictates) explicitly stated in terms that we can compare our outcomes to and decide if, on noneconomic grounds, the outcomes are acceptable. If the outcomes pass the initial screening then we must consider the economic efficiency and equity of the plan. Is the allocation of the costs and benefits of the outcomes acceptable on the additional criteria of economic efficiency and equity? If so, we accept and implement the plan; if not, we recycle through the decision process - construct an alternative solution and apply our decision criteria gain.

This, then, is a brief statement of the problem of constructing and implementing an ecological decision model.

Harvey Perloff[1] has conveniently provided a comprehensive cataloging of the many environments we deal with and the elements that comprise each. However, contrary to his claims, he has not provided a model, but a framework. The task of relating not only the elements within one environment but of the environments one to another is still to be done and will occupy many man-years of labor and much computer time.

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[1] Harvey S. Perloff, editor; "The Quality of the Urban Environment"; Resources for the Future, Inc.; Washington D.C.; 1969

Perloff has identified five basic environments:

1. The Natural Environment
2. The Spatial Environment
3. The Transportation-Utilities Environment
4. The Community-Or-Neighborhood Environment
5. The Microenvironment (household and workplace)

Not only would a comprehensive ecological decision model determine the outcome of decisions on the transportation network but of this outcome on the natural environment as well. Since we are only taking the first step in constructing such a model we make many simplifying assumptions and accent those elements in the decision process deemed essential.

The initial calculations are to determine the space requirements for housing, commerce, government, education, hospitals, recreation and so on, given the technology and constraints present. These space requirements are then inputs into the environmental subsector (items 2-5 immediately above). The outcome of these environmental subsectors then becomes the input into the natural environment sector.

The simulation-game we developed is a first step to approximate this involved decision process for classroom use. The impacts on the environment when compared to the goals will allow a decision to be made. For current purposes this is the end of the game. The players are scored by the cost/benefit model discussed below. However, when fully developed, the augmented model (planning and cost/benefit model together) will provide an effective decision-making aid and learning device.

The Simulation Game

In a study about the environment the normal jargon of the "simulated environment" would be confusing. Therefore, for clarity we chose to deal with a "simulated process".

The Simulated Process

The process that is to be simulated is the decision-making activity of a small community that is currently facing the problem of planning for a 20 year horizon, given projected population increases for the area.

The model to be used at the initial level of the simulation is a condensed version of the mathematical model implicit in an actual community development plan. Another source of inputs into the construction of the model is the "Economic Analysis" of the area. Rather than a behavioral model in its strictest sense, the model used here is an allocative model. That is, given the zoning requirements in existence, the persons per dwelling unit, the types of possible dwelling units and so on, we calculate, for example, the allocation of the projected population into the various types of dwelling units. Some variables determined are the number of single family units and the acres required.

Also using the same plan, equations to calculate the allocation to non-retail use are specified. The residual acreage will be the recreational space available. It was decided to omit the complications of governmental, educational and transportation land requirements at this level.

The period of time of the simulation is 20 years. Another decision was to aggregate the years into five year segments. Therefore, given the initial configuration of the area and population, calculations are made for the needs 5, 10, 15 and 20 years hence. This aggregation greatly reduces the amount of information the participants must assimilate and analyze.

The goals that the plans are designed to meet in an efficient and equitable manner are:

1. To enhance and preserve the spaciousness and attractiveness of the Area in accommodating future growth

2. To provide an adequate and integrated transportation system consistent with the Area's form and needs

3. To provide adequate commercial facilities to satisfy the Area's mercantile needs, arranged and located to provide proper access and compatibility with adjoining uses through design

4. To further encourage and develop the sense of community identity and foster willingness to participate in Area Affairs

5. To provide the framework for a planned and unified community containing a balance of living, working, shopping, educational, civic, cultural, and recreational facilities

6. To provide a permanent park and recreational system of sufficient size and quality to adequately serve the Area's future needs, and consonant with the rising expectations of the community

7. To develop additional tools enabling commercial and industrial (as well as residential) developments to grow and flourish in an efficient and compatible manner.

These goals were determined by a Citizens Advisory Committee composed of "representative" members of the community. Additional input into the determinations of the goals was the "Attitude Survey".

At the initial level of the game, goals 2, 5, and 7 are suppressed. As the complexity of the model and hence, the game is increased, these goals will be introduced incrementally. Furthermore, we assume the area we are dealing with is small enough such that considerations of mass transit, freeways, et cetera are constraints imposed upon the town rather than variables the planner can effect.

The Game Planning Model

The activity of the planner is replaced by a model whose variables, parameters and operating characteristics have been abstracted from the actual plan and supporting documents. This specification of the model is for the initial simulation. The level of complexity increases with each new variable as we approach "reality".

The primary variables are:

Endogenous: residential, nonresidential and recreation acreages. Those must sum to the total acreage. Other variables determined will be the number and types of dwelling units.

Exogenous: population.

The most important parameters are the number of persons per dwelling unit by type of dwelling units and the number of dwelling units by type per acre. Other parameters are the acreage requirements for non-retail (e.g. commercial, parking and schools) use per capita.

The operating characteristics are omitted in this presentation for brevity. Since we are using an allocative as opposed to a behavioral model, I do not feel much is lost. Furthermore, one can formulate a general allocation model with minimum effort. That is, given the population, we just multiply by the appropriate parameters.

The person playing the role of planner will feed changes into the programmed model from the on-line terminal in the classroom and the students will get a modified plan instantly and in a relatively short time they can reach a final decision.

The Game Roles

Additional factors, controlled or response, are the various roles that individuals must play during the simulation. Given the decision initially to use a condensed planning model and deal only with a few variables, the number of roles used initially is low.

Two options are open for the initial version. In the first, the final decision of the Citizens Advisory Committee with only the plan and the planners participation as input is evaluated. In the second, each homeowner's decision (vote) is evaluated with only "newspaper" accounts of the Citizens Advisory Committee, planners interaction, and the plan and the plan as inputs. This latter version would be similar in concept to a usual test.

The decision is to concentrate on the first version. Therefore, two roles must be filled:

1. Students are assigned the roles of members of the Citizens Advisory Committee. They are given the goals of the community and an abstract of the attitude survey.

2. Student (assistant) is assigned the role of planner. He will also have a script and will answer questions within the content provided by the script.

The second basic option would require only one role to be filled:

1. Students are assigned the roles of homeowners (decision makers). They are given the goals of the community and "newspaper" articles of the events and plan.

The newspaper accounts could be reports of version one events or a description of hypothetical situations.

Many variations, extensions and combinations of these two basic versions can be constructed. To do so would require the assignment of additional roles and would be one way incrementally to increase the level of reality in the simulated decision process. The additional roles needed would be:

1. Student (assistant) is assigned the role of spokesman for the developers and provided with the initial plan and a script
2. Student (assistant) is assigned the role of planning consultant and provided with the plan and a script which is an analysis of the plan (possibly a faculty member will fill the role)
3. Student (assistant) is assigned the role of representative of the homeowners. He is provided with the plan and a script.

Play of the Game

The basic format of the game will remain the same as new variables and roles are introduced. We can in this incremental fashion measure the relative impact of additional information on the economic consequences of the students' decisions. We will, for example, fix the number of variables but increase the number of roles (and information) and measure the impact.

Once the roles are assigned, the students acting as the Citizens Advisory Committee are presented a copy of the initial plan in graphic and numeric form. A 15 minute presentation by the instructor (or assistant) with a "map" of the area provides the background necessary to proceed.

The city planner (the representative of the developers and the planning consultant and a homeowner representative in future simulations) will be called in. He will proceed to explain the plan and answer questions--all within a predetermined script. The Citizens Advisory Committee will then after discussion accept the plan or modify it until one plan is accepted that meets the goals of the community. The economic implications of each plan are computed and stored on-line to be outputed at the end of the session. At this time a diagnostic session is undertaken - important points are stressed and questions answered.

The final decision makers are the Citizens Advisory Committee and the game is terminated in a specified period of time. Their final decisions regarding the plan is the outcome upon which relative efficiency, equity calculations, and judgments are determined.

Cost-Benefit Model

The output of the planning model becomes the input into the cost-benefit model. There are two versions of the cost-benefit model: the ideal and the game model.

The Ideal Cost-Benefit Model

Once a plan is formulated we compute the impact on the sub-environments: Spatial, Transportation, Utilities and Community. The technology and constraints that affect these sub-environments will result in outcomes that affect the natural environment.

We must enumerate these outcomes and identify each as a cost or benefit to the society, and, secondly, identify these outcomes as costs or benefits to certain sectors in the society.

Once we have enumerated the costs and benefits we face the difficult task of valuation -- what prices to use? In many cases the benefits (costs) will be extremely difficult or impossible to value since the "item" is not a commodity traded in a marketplace.

Finally we must choose the discount rate and compute the discounted net benefits to (a) the society and (b) the various sectors. These final calculations then provide the measures of economic efficiency and equity needed to "grade" the players.

Considerable effort must go into the development of this model to have it be fully capable of evaluating the impact of private or public programs on the balance of our environments. For the simulation game we have devised, we need but a condensed version of this ideal cost-benefit model.

The Game Cost-Benefit Model

The project to be evaluated is the plan formulated by the players. We need to know the net discounted benefit of the plan and the allocations of the costs and benefits of the plan by sector.

We approach the problem as follows. The city is treated as "the developer" and cost or benefits of the plan accrue to the city. The section to which indirect impacts accrue are identified. Only the highest level of the calculation "tree" is reported here.

1. Direct "City as Developer" Impact Costs to City Government
    - A. Streets and Highways
    - B. Utilities
    - C. Special Direct Costs (e.g. changes in natural environment)
    - D. Local Revenue Change (+/-)
2. Additional Residents Impact on the City Government
    - A. Revenues (benefits to City Government)
    - B. Expenditures (costs to City Government)
3. The Plan's Indirect Impact on Community Business and Residents
    - A. Property Owners (market value change)
    - B. Developers (market value change)
    - C. Retailers (net income change)
    - D. Wage Earners (net income change)

Item 1 would consist of the ancillary needs of new facilities. What good is a civic center without parking roads, sewers and so on? The special direct costs are the impacts on the environments. The revenue change would reflect the net (+/-) change to the city's revenue of removing land (and future buildings) from the tax rolls.

Item 2 would be the net effect on revenue and expenditure of the new residents (and any change in behavior expenditure/use of the old). Included would be increased sales taxes, business licenses, etc.

Item 3 reflects the "private" costs/benefits to accrue to individual groups. These in turn are the sources of additional revenue for the local government referred to in item 4.

This is but an abbreviated statement of the Cost-Benefit model. The model is the subject of a separate paper.

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"COURSES AND MASTER THESES RELATED TO SIMULATION IN THE OPERATIONS RESEARCH CURRICULUM AT THE NAVAL POSTGRADUATE SCHOOL"

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COURSES AND MASTER THESES RELATED TO SIMULATION IN THE OPERATIONS RESEARCH CURRICULUM AT THE NAVAL POSTGRADUATE SCHOOL

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Introduction

The curricula at the Naval Postgraduate School in Monterey, California, includes a two year masters degree curriculum in operations research. Students enrolled in this curriculum are selected from the officer corps of all the U. S. military forces and the military forces of several allied nations. Upon the successful completion of the curriculum the student is awarded a Master of Science degree in Operations Research. The purpose of this paper is to describe certain courses within this curriculum that are related to simulation and to include a descriptive summary of theses submitted for a degree.

I. General Description of the Operations Research Curriculum

A typical list of required courses by title and by quarter for the curriculum is as follows:

Quarter I:	Calculus Linear Algebra Probability Historical Introduction to Operations Analysis Introduction to Decision Analysis
Quarter II:	Advanced Calculus Probability and Statistics Physical Models I Human Factors
Quarter III:	Microeconomics Linear Programming Statistics *System Simulation

Quarter IV: Utility Theory and Resource Allocation
Stochastic Models I
Physical Models II
*Introduction to War Gaming

Quarter V: Systems Analysis I
Data Analysis
Industrial Tour

Quarter VI: Nonlinear and Dynamic Programming
Stochastic Models II
Electives (2)

Quarter VII: Analysis of Information Systems
Network Flows and Graphs
Electives (1)

Quarter VIII: Systems Analysis II
Electives (2)

The curriculum is a comprehensive one that includes at the beginning undergraduate and review as well as graduate and new material. The electives available are many and varied and include, for example, specialized courses in the analysis of military supply systems as well as theoretical courses in advanced probability, statistics and mathematical programming. Also required but not included in the above list is a thesis. All students are required to complete a thesis prior to the awarding of a degree. The content of this thesis may be either applied or theoretical.

The courses in the above list marked by an asterisk are the required courses directly related to simulation. Both of these courses are considered as upper division or graduate courses. Before describing these courses in the next section it is significant to note the quarters in which these courses are taken.

System Simulation is taken in the third quarter primarily because the course requires the student to use the probability and statistics taken previously in Quarters I and II and concurrently in Quarter III. It should be pointed out also that all students are required to learn FORTRAN by attending a noncredit television series presentation prior to Quarter III. Introduction to War Gaming occurs in Quarter IV as a follow on to System Simulation.

Note that in Quarter V the students are required to go on an industrial tour. This is a six week tour in some commercial establishment or government agency which is directly related to the student's area of speciality within operations research. The student at this time usually participates as a contributory member of an operations research group. Because of the wide use of simulation techniques, for both analytical and educational purposes, in industry, universities and government the required courses in simulation are taken prior to this industrial tour. In this way the student can then be a valuable asset in simulation studies he encounters by not only being aware of simulation techniques but by being in an informed position to assist in the evaluation of the studies.

A third course directly related to simulation is the elective, Advanced Topics in War Gaming and Simulation. As an elective this course may be taken in either of the last three quarters.

II. Description of Courses Related to Simulation

System Simulation: The emphasis of this course is to present the broader aspects of computer simulation as a problem-solving technique. The subject material covered includes:

1) Monte Carlo methodology

2) Generation and testing of psuedo random numbers

3) Generation of stochastic variates

4) Computer simulation in FORTRAN

5) Computer simulation in GPSS and any other simulation language available

6) Design of simulation experiments and analysis of results

7) Variance reduction techniques

8) Analog and hybrid simulation

The prerequisites include two quarters of probability and statistics and a knowledge of FORTRAN.

This course is usually problem oriented and as such students are required to turn in home work assignments as well as a term project. Typical problem assignments parallel the material presented in class and could include: the programming and testing of a particular scheme for generating psuedo random numbers from one of several distributions; the simulation of an operational gas station in order to determine some optimal number of attendants as a function of various demands; and the simulation of a surface to air missile system. The term project is a comprehensive one and requires the student to formulate a problem amenable to solution by simulation, indicate why simulation should be used, design and construct a computer simulation, use the simulation to generate data, and then analyze the data. Examples of term projects from the past are: a simulation of hospital procedures related to maternity care in order to increase efficiency; a simulation of aircraft operations on an aircraft carrier in order to increase efficiency of maintenance procedures. Included in this course is programming instruction in GPSS. The computer facilities at the Naval Postgraduate School include an IBM 360/67 and at the present time the only simulation language available is GPSS.

Introduction to War Gaming: The emphasis of this course is to study the philosophical and structural framework of war games, both computer and non-computer, in order to make the student aware of the methodology, purpose and usefulness of war games as a problem solving technique when applied to military problems. For the reader not familiar with war games I offer the broad definition: a war game is the simulation of a military conflict situation. The material covered in this course is:

1) Significance of computer, manual and man-machine war games as educational and analytical tools

2) Construction methodology of war games

3) Analysis of data

4) Constructing and playing games of various types

It is also intended that this course make the student aware of the types of games being used in the Defense Department today as well as the significance of decisions being made based upon war game results. Guest lecturers from various segments of the war gaming community are incorporated into this course as a necessary and desirable part of the content.

This course requires the student to spend time playing several war games. Although the nature of the games played may be analytical, rather than educational, the student is playing the game to learn about war games. The student is required to not only play a game, but to evaluate the game as well. This evaluation includes criticism not only of the game methodology but also of the purpose of the game and to what extent the game accomplishes this purpose.

Although several texts have been written recently about computer simulation, the text material available on the construction methodology and use of manual simulation is scarce. It is also the case that in industry as well as in the military, manual simulations do have an importance related to education and analysis. In the absence of text material the significance and usefulness of manual simulations can probably best be learned by playing and critically reviewing existing games. However, in order to bring existing games of any type into the classroom, it is desirable that the games be simple enough to demonstrate features of importance, complex enough to be interesting to the student and adequately documented. Very few games meet these criteria.

Advanced Topics in War Gaming and Simulation: This course is an elective that the student may take in the second year. This course is basically a student-participating seminar and as such does not include a definite list of information to be covered. Advanced techniques of model development and simulation are discussed with the actual topics selected depending upon the interests of the students and instructor.

The student is required to complete a class and an individual project. These projects are such that the student is required to design, construct and use a simulation on a problem of his choice as an attempt at problem solution. The problems must be operational, and the scope of the problem and simulation must be compatible with the time available. The individual project involves only the student while the class project requires the student to participate and contribute as a member of a research team. Any type or mixture of simulation methods are acceptable.

Other courses in the Operations Research curriculum at the Naval Postgraduate School include the use of simulation. Several economics courses for instance use one or two of the standard economics games as classroom material. The emphasis of these courses, however, is not on simulation and the simulations are used as pedagogical tools to augment regular classroom instruction.

III. Summary of Masters theses

Since 1961, fifty theses or approximately fifteen percent of all theses submitted have dealt directly with a problem involving simulation. These theses have included methods of generating and testing psuedo random numbers, the simulation of various military activities and the use and evaluation of simulations constructed by civilian contracting organizations for the Department of Defense. The Naval Postgraduate School has had since 1963 some sort of on-line visual display device associated with the regular computing facilities. Several theses have included computer games with player participants interpreting and reacting to dynamic computer output as programmed for the data display devices. One such thesis involved the analysis of tactical considerations available to a surface ship commander as he manuevers in an attempt to minimize the hazard from nuclear fallout as a result of a nuclear explosion at sea.

Examples of titles of theses in which the student constructed a simulation in order to solve an operational problem are: A Computer Simulation to Determine the Penetration Probability of an Aircraft over Hostile Terrain; A Computer Simulation to Evaluate the Interactions Between a Guided Missile Destroyer and a Missile Carrying PT Boat; and Mine Delivery Model, The Construction of an Optimum Mine Field. It is of interest to note that no manual simulations have been included in theses and that no simulations contained in theses have had a purely educational purpose. All simulations have been analytical in nature, that is to say, the simulations have had as a purpose the generation of decision making criteria rather than subjecting the player to decision making experience.

IV. Summary

In summary it should be stated that the Operations Research Curriculum at the Naval Postgraduate School does emphasize simulation as a working tool of the operations analyst. This emphasis, however, hopefully does not lead the student to believe that simulation is the cure all for unsolved problems. It is hoped that the student can appreciate the advantages as well as the disadvantages of simulation. This emphasis represents an awareness on the part of the military community in the graduate education of its commissioned officers that simulation is playing an increasingly important role in finding solutions to operational problems.

"SEA WARFARE INTEGRATED MODEL (SWIM)"

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SEA WARFARE INTEGRATED MODEL (SWIM)

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INTRODUCTION

The application of computer wargaming to the study of naval warfare is fascinating work. This paper will discuss one computer model used by the author in naval analyses conducted during the past eighteen months by the Limited War Division of the Joint War Games Agency.

MODEL DESCRIPTION

The Sea Warfare Integrated Model (SWIM) is an event sequenced Monte Carlo simulation of a carrier task force opposed by a submarine force. It incorporates in one model many interactions between forces which formerly could only be found in separate ASW models. For this reason, it provides a convenient method of incorporating naval forces into the study of theater level warfare in which the total land, sea, and air environment is addressed.

Two versions of SWIM are presently operational:

1. An updated version of the basic model which includes additional capabilities for simulating sonar buoy submarine detections, false contacts, a blue information center and the capability of assigning ASW aircraft to more distant submarine contacts

2. A modified version which causes the submarines to remain on the surface and operate as motor torpedo boats. Motor torpedo boats may be armed with either cruise missiles or conventional torpedoes.

The simulation commences with a Blue carrier task force operating in a holding area. Opposing Red submarines are located in patrol stations selected by the gamer. Game interactions are caused by control times input separately for both the task force and submarines.

The carrier force transits from the holding area to a launch area and launches aircraft. The carrier then moves to a recovery area and recovers aircraft. Submarines operating independently attempt to gain contact with the carrier force and conduct attacks. Cruise missiles and conventional torpedoes may be used by the submarines. Detections of submarines cause the task force to take defensive counter measures using destroyers, helicopters, and fixed wing ASW aircraft. Limited intelligence concerning location of the opposition may be provided either side at time intervals determined by the gamer. Figure 1 illustrates the general simulation environment.

Tactics employed by both Blue and Red forces are controlled by a series of input times described as follows:

1. Blue Alert Hour, the task force heads for the launch area and begins to ready its aircraft for launch
2. Blue Defense Hour, all submarines contacted are attacked. Prior to this time submarine contacts are kept under surveillance.
3. Blue Execute Hour, task force aircraft are launched when the task force is in the launch area. Blue Defense Hour is declared simultaneously if it has not already been declared.
4. Blue Radar Hour, designated units begin continuous radar operation; the remainder continue their input mode of radar operation which can be varied

The time schedule which controls Red tactics is as follows:

1. Time-to-Close, submarines close the position of the task force as reported by Red Intelligence Center, and, at the same time, avoid detection
2. Time-to-Approach, submarines approach task force contacts and maintain surveillance
3. Red H-Hour, Red submarines approach and attack task force units. Red weapons are not fired before Red H-Hour

Red and Blue control times are assumed to be controlled from outside the game theater with three exceptions:

1. A concentration of submarine contacts may cause Blue Alert Hour to be declared prior to the input time
2. The first air or sea attack will cause Blue Defense Hour to be declared
3. The first air attack will cause Blue Radar Hour to be declared

GAME OPERATIONS

The task force starts the game by keeping station at a given input speed and course within the initial operating area until Blue Alert Hour is declared. At this time, the task force begins to transit to the launch area. Upon reaching the launch area, the task force keeps station within the launch area until Execute Hour. At this time, the Blue aircraft are launched. The task force then retires to the recovery area. At the completion of recovery, the game ends.

When a submarine contact has been established, certain task force units, depending on the initial contact, will be assigned to the submarine contact if these units are available. If it is before Defense Hour, units assigned to a datum try only to maintain contact until the task force is a safe distance away. If contact is lost and not regained within some predetermined time, the assigned forces rejoin the task force. After Blue Defense Hour, all submarines contacted are attacked as soon as possible. This attack continues until either the submarine is killed or the task force is sufficiently removed from danger of attack.

The game can be played with any mixture of nuclear and conventional submarines. Submarines operate independently throughout the game but all have access to common intelligence broadcasts.

Red submarines begin the game in their input rectangular patrol patterns. Before Time-to-Close, they maintain these patterns except for evading surface ships that violate their assigned area. At Time-to-Close, Red Intelligence becomes an integral part of their capability against the task force. Periodic broadcasts are made to the submarines giving the position of the task force at some previous time. This enables the submarine to commence closing the task force, but they remain a safe distance away from any surface units they detect themselves. After Time-to-Approach, the submarines (except those equipped with cruise missiles) close on all contacts to the point of periscope detection and attempt to parallel the surface unit at periscope range until Red H-Hour. Cruise-missile-equipped submarines close only to the minimum cruise missile firing range.

At Red H-Hour, the attack begins. Submarines without cruise missiles hold contact, select their closest target, and approach for a torpedo attack. In selecting a target, primary consideration is given to aircraft carriers.

Submarines equipped with cruise-missiles attempt to fire their missiles at Red H-Hour. If any contacts are held, these are fired upon. If no contacts are held by cruise-missile submarines, they fire at the last position reported by intelligence information. Submarines fire their missiles until their supply is depleted and then proceed to approach their contacts to attack with torpedoes. Torpedo attacks continue until one side is destroyed, torpedo supply is exhausted, or the game ends.

The sequence of operational events is illustrated in Figure 2.

GAME DETECTIONS

As the game progresses, the model examines the situation to determine if any unit has an opportunity to detect an opposing unit. Opportunities are based upon characteristics input to the model by the user and detections are determined randomly. A median detection range is calculated based upon the condition of the target and the detector. Added to this range is a random component which fluctuates with time. A full understanding of the means used to simulate detections and failures to detect cannot be obtained without a detailed study of the model.

MODEL SELECTION

The selection of a model for use in a theater level war game is based on extensive research to determine the compatibility of the model to the gaming situation under consideration. The gaming situation is usually established through use of a tightly drawn scenario. The model selection phase of a gaming effort is critical to a successful war game. SWIM is well documented and well supported which eases the selection process.

MODEL UTILIZATION

The application of the SWIM model to a war game is accomplished by using a standing data card deck which describes unit parameters and a general card deck which describes the tactical situation to be played.

The standing data deck contains over 700 inputs basically dealing with equipment and environmental parameters. Some examples of inputs are:

1. Radar ranges
2. Detection factors
3. Active sonar propagation loss curves
4. Submarine battery levels

The general deck contains about 150 inputs plus one card for each naval unit played.

Some examples of inputs are:

1. Location and definition of operating areas
2. Red and Blue time schedules
3. Tactical disposition of all forces played
4. Unit offensive and defensive weapons by number and type
5. Speeds of naval units gamed

The general data deck can also be used to modify inputs to the standing data deck. This feature is particularly valuable when a number of runs under varied tactical situations is desired.

Game results are available in several computer printed formats.

1. Statistical Summary - Lists only general battle results such as number of detections, number of weapons fired, and number of units damaged or killed. (See Figure 3).
2. Battle History - General summary of game progress listing time sequenced interactions by unit. (See Figures 4 and 5).
3. Event History - Detailed list of all events generated by the program normally used by experienced programmers

MODEL LIMITATIONS

As is the case with the majority of war gaming models, SWIM has a number of limitations which must be considered by the gamer.

Human factors such as the tactical skills of ship and force commanders are not considered. Tactics based on diversion, confusion and deception require changes to the general data deck for each iteration. All submarine attacks are aggressive in nature, i.e.,

1. A submarine will continue to attack even though detected
2. A submarine will commence an attack with inadequate reserve battery power to complete the attack

A mixed force of submarines and motor torpedo boats cannot be played in one simulation unless discretely timed. Weapon probability of kill combines in one input weapon reliability, acquisition, tracking and hit. Target maneuvers and speed are not considered.

SWIM is a stochastic model, therefore, multiple runs of each trial should be made and statistical techniques applied to the results.

MODEL VIABILITY

The SWIM model has made a significant contribution to naval war gaming. The model design is flexible enough so that its use in gaming other aspects of naval warfare is possible. It has been used with moderate success in the assessment of convoy operations. SWIM shows great promise for use in conjunction with models of the air and ground warfare variety. For the present it provides one of the better methods for assessing the reduction of naval capability in a hostile submarine environment.

CURRENT MODEL MODIFICATIONS

Two recent major modifications to the SWIM program involving conceptual changes have been made. These changes involve two areas.

1. Classification of Surface Contacts by Submarines - If two sensors such as sonar and radar agree on target classification the classification is accepted. Should two sensors disagree on classification the attacking submarine continues to close the contact until a 75 percent probability threshold is reached. A visual sighting is treated a positive classification.
2. Submarine Attack Options - Missile/torpedo equipped submarines have the option of opening to minimum missile range before initiating attack or closing to fire torpedoes

Both of these program changes have increased the capability of the model to handle decisions faced by a submarine commander under actual conditions.

SUMMARY

The relative value of computer wargaming can be debated at great length. It is a rare individual who after being exposed to computer simulations does not develop a position for or against computer gaming. It is extremely important to remember that a war gaming situation is only an approximation of a real situation. War gamers must use care in the extrapolation of simulation results which may be several times removed from reality. Many times a model is given credit for the gamer's mistakes. The SWIM model is one of the more advanced computer simulations useful in the study of naval warfare. It is a valuable "tool" but like any "tool" it is sensitive to the hands that guide it.

GLOSSARY

Blue Alert Hour. The time the task force leave the initial operating area enroute to the launch area.

Blue Defense Hour. The time at which task force units conduct attack operations against submarine contacts.

Blue Execute Hour. The time at which the CVA task force launches its offensive strike aircraft.

Blue Radar Hour. The time at which designated task force units commence continuous radar operation.

CVA Task Force. Attack carrier and its associated task force elements.

CVA Task Group. ASW carrier and associated ASW task group elements.

Red Time-to-Approach. The time at which Red submarines approach task force contacts and maintain surveillance.

Red Time-to-Close. The time at which Red submarines start to close the task force while avoiding detection.

Red H-Hour. The time at which submarine attacks against the task force units commence.

Time-Share Plan. A Blue surface unit radar operation plan.

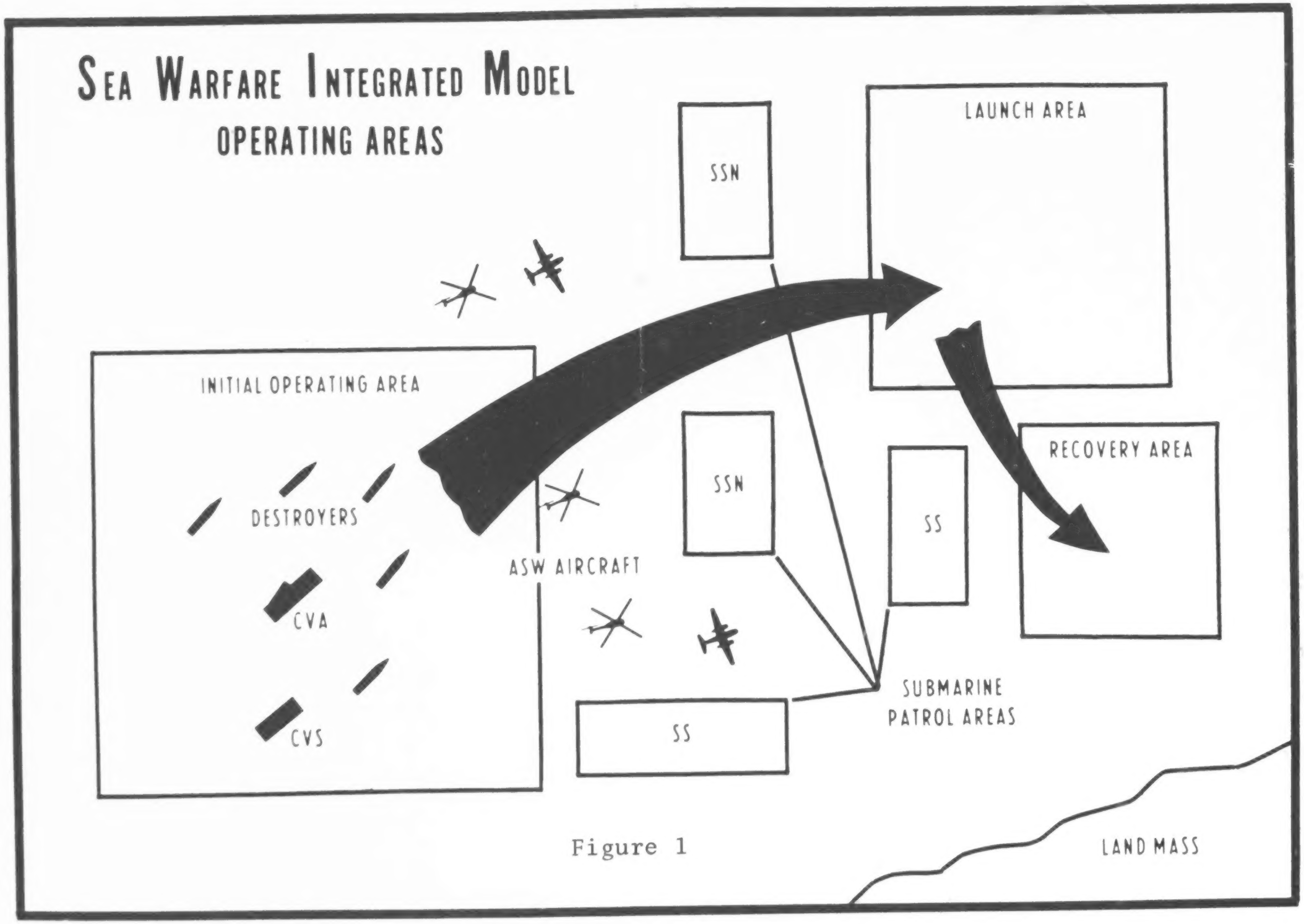
SEA WARFARE INTEGRATED MODEL
OPERATING AREAS
INITIAL OPERATING AREA
DESTROYERS
CVA
CVS
ASW AIRCRAFT
SSN
SSN
SS
SS
SUBMARINE PATROL AREAS
LAUNCH AREA
RECOVERY AREA
LAND MASS

Figure 1

SEA WARFARE INTEGRATED MODEL

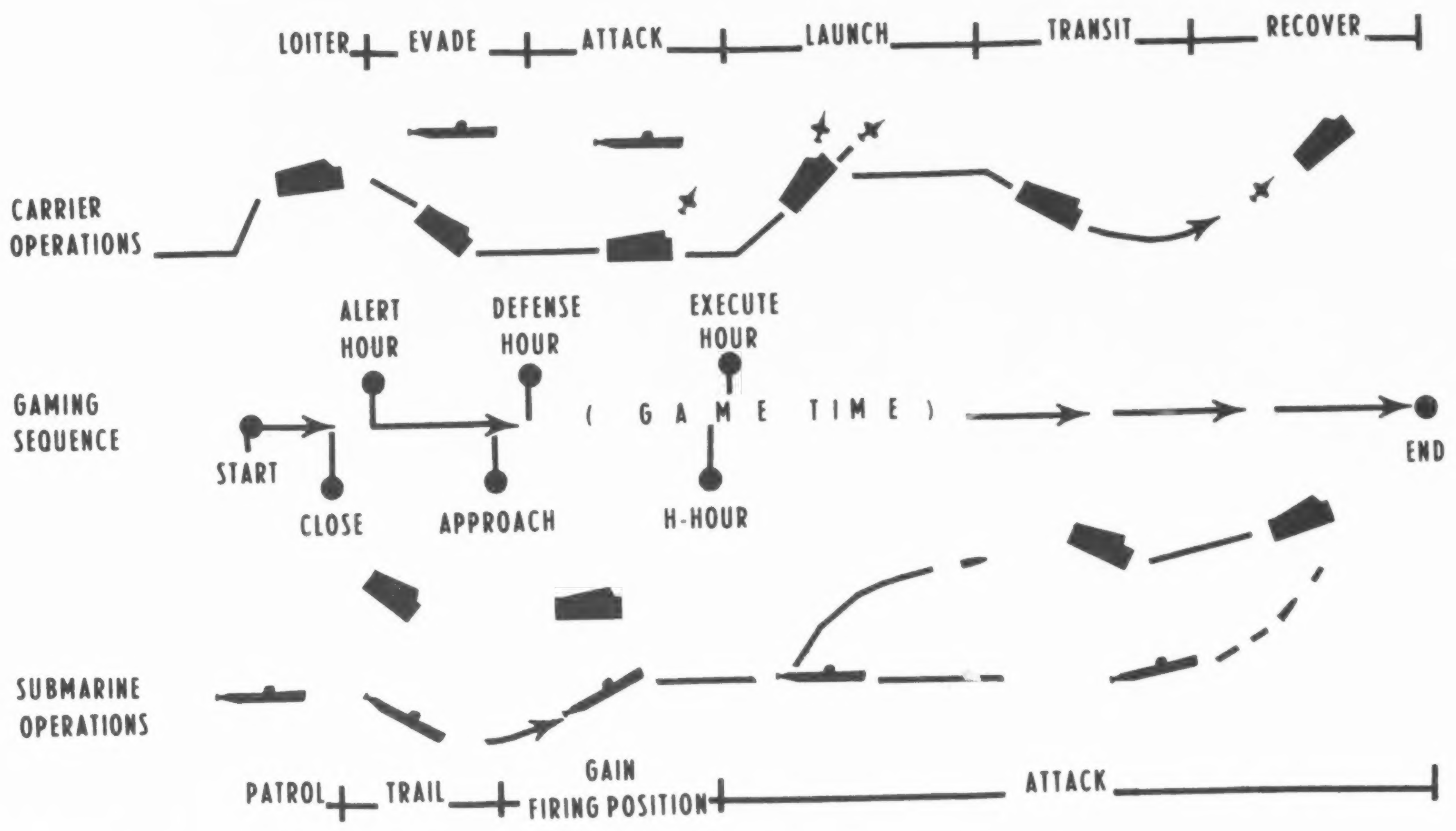
LOITER
EVADE
ATTACK
LAUNCH
TRANSIT
RECOVER
CARRIER OPERATIONS
ALERT HOUR
DEFENSE HOUR
EXECUTE HOUR
GAMING SEQUENCE
(G A M E T I M E)
START
CLOSE
APPROACH
H-HOUR
END
SUBMARINE OPERATIONS
PATROL
TRAIL
GAIN FIRING POSITION
ATTACK

Figure 2

```
0.      * TIME TO CLOSE TASK FORCE
0.      * RED H-HOUR

0.        RSS RESTARTS PATROL
            LAT =     -0.000    LON =     1.000     SSN    1

0.003   * TIME TO APPROACH
0.556     RSS PATROL TURN
            LAT =      0.050    LON =     1.000     SSN    1
1.667     RSS PATROL TURN
            LAT =      0.050    LON =     0.500     SSN    1
2.475     RSS APPROACHING CONTACT
            LATR=     -0.023    LONR=     0.500     SSN    1
            LATB=     -0.024    LONB=     0.487     DD     5
            R=  1.288 VEL=10.00
2.492     RSS UP SCOPE
            LAT =     -0.024    LON =     0.500     SSN    1
            REASON --  TARGET OBSERVATION

2.492     RSS FIRES TORPEDO SALVO
                                TARGET  DD   5      SSN    1

2.494     RSS EVADING SURFACE SHIP
            LATR=     -0.025    LONR=     0.500     SSN    1
            LATB=     -0.024    LONB=     0.491     DD     5
```

SAMPLE BATTLE SUMMARY (RED)

Figure 3

```
TRIAL NUMBER 3


0.     * BLUE ALERT HOUR
            VEL = 18.00
0.     * BLUE DEFENSE HOUR
0.       TASK FORCE TURN
            LATI=   -0.055   LON1=    0.004
            TFI COURSE =  87.38   VEL= 18.00

2.492    BLUE DATUM ESTABLISHED
            LATB=   -0.024   LONB=    0.490    DD   5
            LATR=   -0.024   LONR=    0.500    SSN  1
            DET BY RAD       RANGE=   0.983
            LATD=   -0.024   LOND=    0.502
            FORCES ASSIGNED--    0 HS,  C VS    DD   5
                                     DD   3       DD   4

2.492  * BLUE KILLS RSS              SSN  1    DD   3
            SS WILL DIE AT   2.515
            WEAPON MK 44  ASROC
2.492    UPDATED DATUM LIST
            LATD=   -0.024   LOND=    0.500    SSN  1
               TD=  2.492   FD=  3   QD=  1
2.492    TASK FORCE TURN
            LATI=   -0.034   LON1=    0.452
            TFI COURSE =  87.38   VEL=30.00
2.492    TASK FORCE TURN
            LATI=   -0.034   LON1=    0.452
            TFI COURSE = 123.52   VEL=30.00

2.515    DATUM SCRUBBED
            LATD=   -0.026   LOND=    0.499    SSN  1
2.515    END OF GAME
```

SAMPLE BATTLE SUMMARY (BLUE)

Figure 4

```
                     SWIM TRIAL SUMMARY
                       TRIAL NUMBER 1


CARRIER SUMMARY
   CVA NOT KILLED.         TIME OF THIS SUMMARY      3.75
   CVS NOT KILLED.         NHITS   0
   LAUNCH NOT COMPLETED

ASW INTERACTIONS
   BLUE UNITS KILLED BY TORPEDO      0.
   RED TORPEDO SALVOS FIRED          0.
   CONVENTIONAL RSS KILLED           0.
   NUCLEAR RSS KILLED                5.
   BLUE ASW WEAPONS FIRED           10.
   TOTAL NUMBER OF DATUMS           15.

AAW INTERACTIONS
   BLUE KILLED BY CRUISE MISSILE     1.
   CRUISE MISSILE SALVOS FIRED       5.
   CRUISE MISSILES KILLED            0.
    FOLLOWING BLUE UNITS KILLED      BY CRUISE MISSILE

1        DISPOSITION OF FORCES TIME=       0.
  UNIT                 LATITUDE          LONGITUDE


                SAMPLE STATISTICAL SUMMARY
```

Figure 5

"A COMPUTER-ASSISTED GAME FOR THE EVALUATION OF AIR DEFENSES IN A COMBAT ENVIRONMENT"

Joseph Bodo
Sylvania Electronic Systems

A COMPUTER-ASSISTED GAME FOR THE EVALUATION OF AIR DEFENSES IN A COMBAT ENVIRONMENT

Joseph Bodo
Electronic Defense Laboratories
Sylvania Electronic Systems

ABSTRACT

A gaming model including methodology and supporting rationale for the evaluation of ground based air-defense effectiveness in typical combat environment is presented.

The game formulation includes the characterization of the total air environment; representation of the threat spectrum, attack definition, general and specific scenarios for the employment of the air threat as well as the modelling of the defense capabilities at the functional and operational levels. Models to assess the interaction of penetration aids, electronic countermeasures and counter-countermeasures form a significant part of the resulting engagement scenarios.

The interaction between the offensive forces and the anti-air system is evaluated through spatio-temporal representations of the simulated raids. Quantified measures to evaluate detection, target acquisition, engagement and intercept capabilities are utilized to establish such performance factors as engagement volume, fire power, terminal effectiveness and staying power. These measures are amalgamated to form gross performance indices suitable to define the military worth of the air defenses in terms of deterrence, attrition and damage limiting capabilities gainst the specified threat.

Copies of paper will be available for conference.

"THE USE OF CARMONETTE IN EVALUATING THE EFFECTIVENESS OF NIGHT VISION DEVICES"

Norman W. Parsons
Research Analysis Corporation

Abstract

THE USE OF CARMONETTE IN EVALUATING THE EFFECTIVENESS OF NIGHT VISION DEVICES

Norman W. Parsons
Research Analysis Corporation

CARMONETTE is a fully computerized war game developed by the Operations Research Office (ORO), in the late 1950s. The gaming techniques have been expanded and the use of the game has been continued by the Research Analysis Corporation, ORO's successor.

The basic CARMONETTE is a small unit battle simulation which can portray the actions of battalion-sized forces in battles up to 90 minutes in length. The results of battle are measured in terms of casualties to each side and the extent of advance of the attacker. The results of battle depend on the input of detailed performance characteristics of the weapons being played. These include hit and kill probabilities and the times required to load or reload, aim and fire the weapon concerned. CARMONETTE can simulate the operations of infantry, armor, antitank, artillery and mortar, and armed helicopter forces.

The most recent application of CARMONETTE has involved the addition of target detection routines for night vision devices. The probabilities of target detection are dependent on the technical characteristics of the type device concerned, the natural light, and the target and background reflectance.

Exercise of the revised model showed that the outcomes of battles were sensitive to the availability of night vision devices and to light levels.

The model is proposed as a technique to assist in the determination of the basis of issue for night vision devices.

"STOPS: A STABILITY OPERATIONS SIMULATION"

R. E. Zimmerman
Research Analysis Corporation

STOPS:
A STABILITY OPERATIONS SIMULATION

R. E. Zimmerman
Research Analysis Corporation

ABSTRACT

FOREWON is a large force planning model developed by RAC in the last 2 years. It requires a combat simulator in order to function. The RAC computer simulation ATLAS performs this function for conventional wars with a FEBA. STOPS was designed as the FOREWON combat simulator for mid and high intensity Stability Operations such as are found in South Vietnam. Its purpose is to relate the development of population control as a result of strictly military operations. That there is a strong connection between these two factors has been established by the work reported in RAC TP-309 and confirmed by a test of STOPS.

STOPS is a statistical model. Multiple Regression techniques (i.e. least squares) have been used to establish a correlation between, (1) a list of independent variables selected from a large body of statistical data concerning the Vietnam insurgency and (2) population control in the four Corps areas as reported in the literature. The best set of four or so independent variables were selected and the correlation coefficients calculated. This produced linear equations which could be used to predict population control when the independent variables took on values different from the Vietnam experience. It is recognized that this imputes a cause and effect relationship between population control and the independent variables not warranted by the statistical techniques used to relate them. Nevertheless, the tests made of the resulting model seems to validate the imputation.

The paper presents the independent variables and discusses briefly the test runs.

"THE DESIGN DILEMMA: GAMES FOR WHOM?"

Harold W. Adams
Graduate School of Public Affairs
Suny at Albany

GAMES FOR WHOM?: THE DESIGN DILEMMA

Harold W. Adams
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State University of New York at Albany

Introduction

Social science games are beginning to come of age. They derive from war gaming, and they have the same purposes. On the one hand, games are useful to gain an appreciation -- ideally, with predictive validity -- of the processes and structure through which military or social situations move from one state to another. On the other hand, games are useful for the insights they give players into the likely consequences of their decisions on situation state transition. The argument of this paper is that a potential conflict exists between the scientific and the tutorial uses of gaming: between games that are useful to the research worker and those which are useful to the player. The suggestion is also made that the conflict can be overcome through skillful game design.

The Designer's Problem

Games are little understood beyond the handful of people who have actually designed them. Necessarily, these designers determine which and what kind of games exist. The major constraint on their designs is the availability of funds to support their work. In the nature of things, sources of funding want to know what is being bought. The funding requirements of games are by most standards quite high. A hundred thousand dollars can be used up with relative ease. For amounts of this sort, most fund sources require very significant justification. Given the lack of full understanding of what is involved in game design on the part of those with funds, one gains justification primarily by playing a prototype game, since demonstrating predictive validity is, in most cases, beyond our grasp at the start. Thus, it is to the designer's advantage to make a game that is convincingly playable.

An uncomfortable design tradeoff emerges at this point. Predictive validity generally appears obtainable only by building great complexity into the game -- at points approaching one-to-one replication of the real-world situation being modeled. Yet such complexity generally works against a player who is able to devote only a limited amount of time and intellectual energy to playing the game. Quite simply, the player is unable to keep track of the relation between the action he takes and the situational consequences that emerge from his action. Thus, the game may take on the image in the player's mind of "black magic." For all the fascination that magic holds for most people, it is not sufficient to justify major contributions of scarce resources. So, if one wants to design a tool of advanced social science research, he does well to endow his creation with a certain amount of face validity for the player.

However desirable it may be for the designer to make a game the player can comprehend, he is usually successful only if player comprehension is one of his conscious objectives from the start. If it is not a conscious objective, the designer is soon caught up in a special form of myopia that works against player comprehension. For one thing, the designer has such intimate knowledge of his game that he inadvertantly assumes the player has equal knowledge. For another, the sheer intellectual appeal of adding "yet one more" element of situation or process simulation is immensely satisfying to the creative instincts of the designer, and holds forth the enchanting promise of approaching more nearly the predictive validity that any self-respecting scientist seeks. But, the more complex the situation simulation, the more difficult it becomes to explain the game to the player, and the less likely the player is to understand game dynamics.

An Illustration: Urban Games

Recent progress in urban gaming presents an excellent illustration of this design dilemma. The sequence that begins with Monopoly and Square Mile, continues through the Community Land Use Game (CLUG) and Metropolis, and has emerged into City and Region is one of increasing complexity and decreasing player utility.[1] Thus, though still short of scientific prediction, we are indreasingly faced with player alienation.

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[1] Allan G. Feldt; "The Cornell Land Use Game"; Miscellaneous Papers No. 3; Center for Housing and Environmental Studies, Cornell University, Ithaca, New York; 1964. Also, derivative games include the "Son of CLUG" series: Margaret Warne; "CLUG: Agricultural Land Use Modification"; mimeographed; Cornell University, Ithaca, New York; 1967 (which concerns the transition of farm land to housing)and "New Town"; New Town, 118 North Tioga Street, Ithaca, New York (which treats what the name implies). Richard D. Duke; "Gaming Simulation in Urban Research"; Institute for Community Development and Services, Michigan State University, East Lansing, Michigan; 1964 (which discusses the Metropolis game). See also "City I" and "Region: An Urban Development Model"; Washington Center for Metropolitan Studies, 1717 Massachusetts Avenue, N.W., Washington, D.C.; 1968.

Monopoly and Square Mile -- the first generation of urban games -- captured player interest enough to make them profitable on the competitive market. The player understood his role as a real-estate developer. He was caught up in the challenge to make more money than other players so that he could "win." He felt he understood, albeit in nondeterminate fashion, the pattern of decisions and actions most likely to produce profitable results. The games "grabbed him." But, for the scientist, both games were little more than toys. Chance was much too dominant in Monopoly; return on investment was too large and too automatic in Square Mile. The slice of life simulated in both was too independent of the noneconomic elements of community activity to have the flavor of the world we really live in.

CLUG and Metropolis are more than toys, yet suffer the defect inherent in this virtue. CLUG presents an interrelated community in which community as well as individual decisions must be made and in which the situation the players find themselves in is far more like the world they see each day. The emphasis is still heavily economic, and transportation is perhaps overly dominant, but real-estate development is presented with far more richness than in the first-generation games. The political vector is also there, but in an extremely idealized form. Metropolis takes the political vector as a more central concern by adding the roles of politician and planner to that of the developer. Where CLUG works with an idealized city, Metropolis uses a far more fine-grain simulation of land use that enables a specific city to be mapped as the game locale. Thus, Metropolis adds both role and land use complexity, absent from CLUG, and presents a correspondingly richer world as the player-embedding simulation. These advantages are not without their costs. The costs of initial design, game setup, player pre-game learning, and the time the player must devote to play are far beyond those of earlier games -- an eight-hour day is nearly always a minimum. The decision-processes-consequences sequence is less clear in the mind of most players. And, a game simply cannot be entered into on the spur of the moment after dinner and drinks. Costs aside, however, with these games we have moved a good deal closer to science. The cities that emerge, and the processes by which they develop go far to explain the rough structure of cities and processes that we see each day. Players are rewarded for their effort with a deeper appreciation of complex urban processes.

City and Region, essentially formed by fusion and expansion of CLUG and Metropolis, continue the trend away from the player and nearer to a tool of social science. Economics, politics, and planning interact simultaneously. Player allegiances are split between team gain and community betterment. Land uses are expanded. Considerations for decision-making are far more complex. The city grows into the surrounding territory; decay and rebirth occur in the urban center. Information deluges the players and strains their sorting capacity. Realistic administrative impediments appear at every action point. Intrateam role definition has become formalized, and separate players rarely know the "whole story." Consequences can only dimly be related to decisions previously made. Setup time and out-of-pocket costs have gone beyond the capacity of individuals and strain the capacity of small organizations. Yet, a city develops out of the theories of social science that have been folded into the simulation. And this city looks like the cities around us. We have the main ingredients of science -- theory explaining observation. We have scientific advance in more meaningful detail at the price of the situation dominating the player. We should not deprecate the dimensions of the scientific advance: City and Region have done what universities have generally failed to do; they have given the sociologist, the political scientist, and the city planner the ability to pool their separate contributions in a meaningful manner, and at a meaningful level of detail.

Dimensions of the Design Dilemma

Design decisions address design purposes: we choose with an eye to what we wish to achieve. But the dimensions of design choices -- the process considerations that link choice and purposes -- are varied, interrelated, and often internally conflicting. These dimensions, as I see it, are concerned with the answers to six central questions:

1. Cost: how much time and effort will be required to design, develop, operate, and play the game?

2. Benefit: to what degree are the designer and player viewed as the beneficiaries of game play?

3. Granularity: to what degree of precision are situation processes to be simulated?

4. Validity: to what degree of precision and accuracy is the outcome of play expected to show "how things would really happen"?

5. Dominance: to what degree will chance, player personality, player role, and situation simulation dominate play and game outcomes?

6. Visibility: to what degree of clarity and precision will a player be able to relate his actions to situational changes and game outcomes?

For the purposes of this paper we will focus mainly on the tradeoffs between the designer and the player as beneficiaries and between granularity and visibility as they affect benefit production. The area of concern is "complex games" -- those at the level of complexity of CLUG, Metropolis, City, and Region.

First, since our problem is with complex games, what is it that makes a game "complex"? Complexity is a function of the degree of articulation of the variables, on the one hand, and the degree of interplay of these variables, on the other. The more variables there are, the more complexity there will be. Parallel interplay of variables yields more complexity than serial interplay; similarly, recursion yields more complexity than lineal sequencing. The degree of both these determinants of complexity is determined by simulation granularity. The finer the grain -- the more precise the specification of process and output variables -- the more complex the simulation.

As granularity increases, demands on players increase. And, since players generally have a limited amount of time they can devote to learning and playing games, increased granularity decreases the likelihood that players will understand the game and their role in it. Simply, the more complicated the picture the game presents to the player, the less likely the player is to "get the picture" clearly in mind. That this leads to player disaffection and alienation is but one part of the penalty for lack of player understanding. The other part is a possible decrease in game validity -- the purpose of increased granularity in the first place. For, games generally assume that players replicate real-situation actors. If players have less understanding of the likely effects of their decisions than real-life actors have, then an element of nonrepresentativeness has been entered into the total game simulation.

Thus, increased granularity often works to decrease visibility and validity. This is a central design tradeoff in complex games. If the only designer control point is degree of granularity, then the only hope for resolving the dilemma is some intellectual breakthrough that would allow us to achieve a low-granularity, high-validity game. This, given the current state-of-the-art in the social sciences, is unlikely for all but the smallest-scope game. Perhaps we could achieve it for a single city block, but hardly for a whole city.

Overcoming the Dilemma

Wide-scope complex games useful to both players and designers require some designer control point other than level of granularity. What seems most appropriate is to separate the problem of situation simulation into its two components. All games represent the world twice: once for the definition of game structure and once for the definition of player role and options. In complex games, the form of these definitions is generally a computer program to explain things to the machine and a manual or other pre-game briefing to explain things to the players. The argument of this paper is that for complex games to progress the designer must handle each situation simulation separately.

Avoiding the horns of the design dilemma is a matter of taking advantage of the two modes of describing the situation. Consider the stored simulation as a related set of processors. Each processor is of the standard form: inputs are received either from inside or outside the computer, they are processed, and outputs are sent either to another processor or outside the computer. Although the processing procedures are essential to the simulation, the player is concerned mainly with inputs and outputs. Further, the player may only be concerned with the input and output of a set of processors. In fact, from the point of view of the player, one could be concerned with the whole simulation as a black box -- if this input, then that output.

The latter approach -- one big black box -- is probably impossible, and almost certainly undesirable for the games with which we are concerned. If the player decision function were simple enough to allow a set of one-to-one if-then pairings, the player could be dispensed with, and a fully rule-following simulation would be in order. But, somewhere between the black-box mode and the current player-oriented descriptions of, for example, Region, one could conceivably develop a pre-game player orientation that is both simpler and clearer than what now exists.

Developing such an orientation for existing games is less likely than developing one for future games. For, to develop such an orientation implies that the simulation logic of the game is, from the point of view of the player, in the form of a nested set of a limited number of basic processing operations (say, a dozen or so) each of which is subdivided for machine processing into a suitable set of subsidiary processes and between each of which there is a severely limited amount of interplay. In most existing games, however, the machine logic has been developed from the point of view of the designer -- which, barring fortuitous accident, is different from the way the player looks at things.

Is it possible to develop a clear, simple pre-game orientation for the player? The thirty-year history of econometric simulations suggests that it is. The early econometric simulations (for example, that of Klein)[2] had a relatively low level of granularity. The recent simulations (for example, that of Brookings) have a quite high level of granularity. Yet, were one to develop an econometric game using the Brookings model,[3] it is likely that one could use players with little formal background in advanced economics and trust that they would understand what was expected of them and what they could expect if they took this action or that.

The trick lies in designing a hierarchical simulation logic in which the player simulation is aggregated and the computer simulation is disaggregated into subsets of the player simulation, that is, where the machine instructions consist of highly articulated modules and the player instructions consist of the same modules viewed almost as input-output "black boxes." And, I would argue, the player instructions are sufficient, despite their lack of detailed process specifications, to give the player the degree of understanding the real-world actor has of the decision-effect chain. Planners, speculators, and politicians generally perceive the urban situation as a rather gross if-then decision space where the processes intervening between "if" and "then" are comprehended in only the most aggregate manner. While it could be argued that these real-world actors have in effect a more granular processing in their subconscious minds, we are in gaming constrained to deal with only the conscious player mind. Thus, pragmatically, the implicit program of real-world players is not meaningful to our problem of instructing the players' conscious program for playing the game.

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[2] The best introduction to the Klein series of models is found in Lawrence R. Klein, "Economic Fluctuations in the United States, 1921-1941"; John Wiley, New York; 1950, and Lawrence R. Klein and A. S. Goldberger, "An Econometric Model of the United States, 1929-1952"; North Holland, Amsterdam, Netherlands; 1964. Whereas the Klein models are on the order of 50 equations, an elegant simplification of this model to less than 10 equations is shown in Henry Theil, John C. G. Boot, and Teun Kloek; "Operations Research and

If my argument is sound, then the designer ought to approach game development as a parallel simulation process -- one for the scientist, one for the player. In many ways, the actual machine logic design works this way anyhow. One begins with gross variables and relations among them, and proceeds by steps to add granularity by disaggregation. If the need for a dual situation description is recognized from the start of the design -- as part of the agenda of design standards -- then it will require little additional effort to incorporate both machine and player instructions into the procedure of design documentation.

But an additional step needs to be added. Generally, the designer's heart is in the machine simulation. The game manual and pre-game briefing are constructed almost as afterthoughts, often viewed as mere necessary annoyances. Yet, just as the annoying process of shaking down the computer program is a fact of life in dealing with the machine, so the player instructions need to be shaken down as a fact of life in dealing with players. A necessary part of game design, therefore, appears to be the development of an effective mode of player instruction. A player-engineered situation description is likely to go through a series of successive approximations before it emerges in useful form. And, for complex games, the final form is likely to be a manual, then a

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Quantitative Economics"; McGraw-Hill, New York; 1965; pp. 77-84. The Klein model has been done up into an econometric game, "Econometric Gaming: A Kit for Computer Analysis of Macroeconomic Models"; Macmillan, New York; 1969.

3. Gary Fromm and Paul Taubman; "Policy Simulations with an Econometric Model"; Brookings Institution, Washington, D.C.; 1968. This reports on the use of the 300+-equation Brookings model. The hierarchical logic of this "monster" program is well displayed in the flow diagram on pp. 3-4. The predictive validity of this and other models of the same class may be another matter; see, for example, "Bad Year for Econometrics"; Business Week, December 20, 1969; pp. 36-40.

briefing, then a practice play before the full play of the game begins. The manual in this case should probably be less detailed than those now used: ten pages is probably better than twenty if the ten pages present the game description as a series of black-box modules whose internal structure the player has to work out for himself as the game proceeds.

One hesitates to make the designer's job more difficult. But one's hesitation is overcome because the potential rewards seem to outweigh the costs. Players are necessary to scientific games until the time comes when we can replace them with algorithms. And, for scientific purposes, the players had better understand what they are about when they play.

Writing the simulation in two languages seems the best way to keep the player in the game and thus keep the game near the world we know. We need to talk both machine language and player language. Two sets of instructions, each tailored to the separate user capabilities, seems the way to design oneself out of the game design dilemma.

"GAMING SIMULATION OF URBAN SPATIAL PROCESSES"

Barry M. Kibel
Boise Cascade Urban Development

GAMING SIMULATION OF URBAN SPATIAL PROCESSES

Barry M. Kibel*

Introduction

The urban environment - and by this is meant the physical, economic, political, and social forces acting in concert in a given urban area - has both spatial (locational) and non-spatial (location-free) components. These are seldom separable, however: Spatial processes have non-spatial aspects and repercussions. For example, a freeway locational decision creates social and economic unrest. Conversely, there are spatial implications to non-spatial phenomena. A budget, for example, essentially deals with monetary distribution among operating units, yet has many locational consequences inherent within it. In this paper, a series of non-computerized games will be discussed which focus on locational processes. As suggested in the above preamble, however, much of the attention will correctly be given to non-spatial factors.

The urban environment is a highly interdependent social system. Decisions affecting one part of this system have repercussions extending in varying ways and to various degrees to all other parts of the system. Actions undertaken which directly influence one part of the urban system have two types of impact felt by all other parts: (1) the direct "disruption" caused by these actions result in a series of indirect disruptions, with both beneficial and harmful consequences (depending on whom is being disrupted and how he - or it - is being disrupted) and (2) the monetary and human costs of these actions can be viewed as monetary and human resources which are no longer available to be spent elsewhere in the system.

The urban environment is highly behavioral. The forces at work in our urban areas are largely the products of human decisions. The bulk of these decisions are made independently by individuals exercising their free will. However, the latitude and diversity of these "private decisions" is largely determined by a much smaller number of public and private decisions made by the economic, social, and political leaders of our society. These latter decisions have been referred to in the literature as "priming decisions", whereas the multitude of resulting private decisions are called "secondary decisions". It is the interplay of priming and secondary decisions which is at the heart of all urban spatial processes.

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The urban environment is in continual flux. Individual and group decisions result in the decay, abandonment, or disappearance of physical, social, and economic units; and in the birth or development of new units. These births and deaths are often of a collective nature; thus, whole neighborhoods decay and undergo shifts in character or functional use, other neighborhoods are created in formerly vacant hinterlands.

The urban environment is a drama being enacted simultaneously at different social, economic, and political levels. While the fate of the economy of a community is being determined in a cigar smoke-filled room, a young black girl is attempting to organize a consumer education program in our neighborhood. While the Mets are defeating the Cardinals, former homes are being bulldozed over to prepare for a new freeway link. The significance of each varies markedly depending on one's point of reference.

Urban Modeling and Urban Gaming

A model, by definition, is a representation of reality; presumably conceived to aid in the understanding of that segment of reality being depicted. The purpose of urban models is to assist in the understanding of aspects of the urban environment. Given the above described nature of the urban environment, one could posit that an ideal urban model would (1) treat both spatial and nonspatial factors in concert; (2) would be systemic in character; (3) contain a multitude of behavioral elements; (4) create dynamic outputs; and (5) deal simultaneously with various levels of social, economic, and political processes. This is perhaps too much to require of any single model. In fact, it might rightly be argued that an attempt to create such an all-in-one urban model would be self-defeating - its complexity would boggle the mind and not reduce reality to workable proportions. However, a series of models - building upon and reinforcing one another - might collectively approach the ideal without sacrificing the elegance of simplicity. The beginnings of such a series are offered below.

There is no theory of the city, no laws of urban behavior which have gained widespread acceptance. Urban analysis and experimentation are consequently fragmental at best, and often ill-conceived. New tools and techniques are continually being invented to replace outmoded ones. Priorities and foci of urban research are constantly being redefined.

Hence, this subject matter is ideally suited for manual gaming simulation of the type presented in this paper. When laws exist and theories are accepted as reasonable descriptions of reality, formalized models are in order. However, when the opposite is true - as it is in the case of the city - a style of modeling is required which is highly flexible and capable of instant refinement and modification. Manual games offer this possibility. Furthermore, manual games - if well-conceived - provide an additional fringe benefit: they create an arena wherein the game participants can provide missing parts of the reality being simulated. Thus, the realism of the game exceeds that of the game design itself.

The LOC-Series of Games

The LOC-series of games (which deal with locational behavior in the urban environment, and presently number 6 in total) were originally developed by the author as part of a seminar he devised and conducted at the University of California at Berkeley in the Spring of 1969. Unlike most modeling efforts which address themselves to the replication of a specific aspect of the real world, the LOC-games evolved from week to week with no specific target in sight either explicitly or implicitly. The objective, rather, was to take the previous generation game and modify it in enough substantive ways so that (1) additional realism would be achieved and (2) new and different challenges would be offered to the game participants (who remained relatively constant from week to week). As it turned out, the objective was achieved and large chunks of reality were absorbed within the gaming framework at virtually no cost and in relatively few manhours (less than eight manhours of development and preparation per game). Of course, with due modesty, the author had a fair amount of experience with and understanding of games and the aspects of reality being simulated here.

Because the games were largely developed for play within a seminar setting, they were limited in scope and complexity by the following constraints: (1) it was highly desirable to be able to explain and play the games within a single 3-hour time frame; (2) the number of roles was limited to a maximum of 15, and allowances had to be made for the contingency that perhaps no more than 10 persons would appear to play a given game; (3) the game room facilities were limited to at best four 3 ft. × 6 ft. tables and an appropriate number of chairs, three blackboards, each approximately 3 ft. × 5 ft. and a total floor area which was just sufficiently large to allow minimal passage if all four tables were utilized.

One positive feature of this design milieu was that the players by virtue of playing a sequence of games, quickly learned the rules of the newer games and made less mistakes while playing the games than a continual flow of new players each time would have made. Furthermore, when visitors took part in the game play, they found themselves surrounded by experienced players and were consequently more receptive to the game; and also were prepared to begin playing quite quickly, knowing that they could ask their neighbor questions about the game rules as play proceeded.

Because of word limitations set by the editor, it is not possible to present the entire series of LOC-games here. Instead, the rules of two of the games will be presented as illustrative of the series and of the fact that the various games address themselves to different facets of the same overall problem of locational behavior.

The Game of LOC-1: A Simulation of Economic Locational Processes

The first game in the series, LOC-1, focused on the individual economic decision-maker in his role as selector of economically viable locations for setting up or expanding activities. The hypotheses upon which the game was designed were that (1) these decisions would become increasingly imitative, as opposed to innovative, as the locational process of all the actors matured; (2) increasingly rational (profitable) spatial patterns would develop over time; and (3) that externally-produced disruptions would create temporary disequilibrium states in the locational process.

A relatively simple board game was employed to simulate the above tendencies. The components and features of the game, the game rules and the game instruments were as follows:

Playing Board: The game board consisted of a square board divided into 100 equally-sized blank squares in a 10 × 10 array representing economic space and containing 100 possible locations in which to establish a firm. Values of "1" to "20" inclusively were assigned to the cells in a predetermined, non-random manner known only to the game controller. The values were assigned in such a way that the optimum pattern, when and if discovered by the players resembled retail land use patterns typical of urban areas (that is, the optimum pattern consisted of a series of centers and subcenters arrayed in clusters and linear extensions). The players were told that "20" was the highest value possible, but were not given any clues as to the distribution of values or if in fact there were squares valued at "20" on the board.

Players: Four to six persons each with 5 "establishments" (represented by colored poker chips) to locate during the course of the game. Each person ("multi-decisional actor") was assigned a different color to distinguish his firms from those of the other players. (Numbered chips would have served the same purpose.) Each player began the game with 50 units of financial resources.

Costs and Rewards: It costs 15 units of resources to locate or relocate a firm, and 5 units to maintain it in operation each round. Upon locating in a square, the owner of the firm was told its value privately and credited with that value (as gross revenues) for each round in which the firm remained in that square. Thus, if the cell was valued at "10," it cost the player 20 units for the first round (15 for location and 5 for operation) and 5 units thereafter, and he received a steady round-by-round payoff of 10 units. (Note: an excellent investment, since a 33-1/3% first year return on initial investment.) A player could remove one or more chips from the board before any new round began at no cost to him, but also without receiving any payment for investment capital abandoned.

Multiple Occupancy of a Square: A player was permitted to move to a cell currently occupied by himself or by another player or players. It cost 15 units to move into a cell occupied by other players but only 10 units to move into a cell already occupied by that same player (expansion costs rather than initial investment capital). However, for each firm after the first which located in a square, the value of that square for all firms - including the original one - was diminished by 2 units. Thus, for example, if four firms belonging to one or more players occupied a square initially valued at, say, 16, each of the four firms received a payoff each round of 10 units $(16-(2\times3)=10)$ less 5 units for operating expense.

Localization Economies: If four or more adjacent squares were occupied, either by one player or many, the operating cost per round for the firms in these cells was reduced from 5 units to 3 units.

Public Information: After certain rounds determined by the game controller (usually every other round), some information concerning the values of the game board was revealed to all the players at no cost to them. This was done by selecting a random card from a deck marked 1 to 100 and revealing the value of that square. (For example, if card 75 was drawn, the value of the square in the 8th row, 5th column was revealed to all the players.)

Parametric Shifts: Occasionally, at an appropriate point in the game as determined by the game controller, some public information was revealed which either altered the values of the game board (for example: "all values in the first row are increased by 3 units") or served as an especially revealing clue (for example: "the left center portion of the game board contains a high payoff area"). The choice of the parametric shift which was introduced was left to the discretion of the game controller.

Private Information: After each round private bargaining among the players was permitted. This bargaining was, however, limited to written messages. The messages (requests and responses) were restricted to the following three types:

1) I will pay you _____ units if you tell me the value of cell _____.
2) I will tell you the value of cell _____ if you pay me _____ units.
3) The value of cell _____ is _____ units. Transfer _____ units to me.

Bankruptcy: If during the game play a player's resource position (initial resource units less costs plus revenues) became negative, that player was allowed to continue if he desired. However, his location and expansion costs were increased from 15 and 10 units to 20 and 15 units respectively (reflecting a higher interest rate on capital borrowed.)

Game Play:

1) Each round, the players were given the opportunity to locate or relocate one firm or to pass. All moves were prerecorded on data sheets, along with a short statement outlining the reason for making the move in question. All players then made their moves simultaneously. At the same time, any number of firms could be removed from the game board.

2) After each round, the game controller revealed the value of that square in which a player had located to that player alone.

3) After each round, the players recorded their expenses and revenues, and their current resource position. They were also requested to estimate what their expected revenue per round would be by the conclusion of the game.

4) Negotiations for private information then occurred for a limited period of time or until no more time was required by the players.

5) Public information and/or parametric shifts were introduced before certain rounds at the discretion of the game controller.

6) The game lasted n rounds where n was preset at 10 rounds and allowed to expand slightly to allow equilibrium to

occur or be approached.

7) The objective of the game was not revealed to the players. They could either play for resource maximization or to meet expectation levels.

Game Instrumentation:

1) A cardboard playing board (2 ft. by 2 ft.) divided into 100 identical squares in a 10 × 10 array and labeled 1 to 10 horizontally and A to J vertically.

2) Five colored poker chips for each player.

3) A balance sheet for each player with columns for recording round numbers; moves; expenses, revenues and current resource position; and for estimating expected revenue flow per round by the conclusion of the game.

4) Scratch sheets for use by the players for keeping track of cell values, opposing player moves, and for planning future strategies.

5) A master sheet kept by the controller indicating the value of each square.

6) A deck of 100 cards numbered 1 to 100 for selecting randomly the square whose value was to be revealed as public information.

7) Message pads for sending private information requests and replies.

The Game of LOC-5: A Community-Level Game of Locational Behavior

LOC-5 was a relatively simple game designed to portray a political process in a typical urban community. The game focused on spatial issues; that is, the players' actions and rewards were centered around the location of chips on the game board.

Types of Player Roles: There were two general types of players in the game: the community players (those who placed chips on the game board) and the politicians (those who altered the values on the game board by their decisions). Roles within these two general types were further broken down as follows:

Community Players	Politicians
upper income residents	conservatives
middle income residents	moderate
lower income residents	liberals
economic actors	radicals

The Game Board: The game board was divided into 100 cells, each having unknown payoffs for the various community players. For example, cell C10 may have payed +5 points for every upper income chip located there, +3 points for every middle income chip located there, 0 points for every low income chip located there, and -3 points for every economic chip located there.

Rules for Community Players: Each community player was assigned 5 chips. These chips could be located on any of the 100 cells on the game board, with the single exception that no player could locate more than one of his chips on the same cell. (A player was allowed to locate one of his chips in a cell containing a chip of a rival player.) For each round in which a chip was located in a given cell, the player received the value of that cell as his payoff (economic or social profit) for that chip. Upon locating in a cell, the value of that cell was revealed to that player alone.

At the start of the game, the chips of the various players were placed on the game board by the game controller. These selections are made so as to insure that each chip would initially have a positive payoff. The payoffs were not, however, the best that the players could do. Each round, the players were permitted to change the location of one chip if they so desired. The object of the game for the community players was to earn as many points as possible by the end of the game (round 20).

In addition to the points earned from the cells in which their chips were located, community players could earn extra points in two ways: (1) by being in the same cells or in one of the surrounding cells of the cells which contained bonus chips (how bonus chips were placed on the board is explained below) and (2) by achieving personal objectives (as explained below and on the individual game role sheets).

Control of Political Power by Community Players: Each community player had assigned to him some units of political power which he utilized during elections to delegate power to his chosen candidate or candidates among the political players. This political power was distributed as follows:

low income players jointly control	25 units
middle income players jointly control	25 units
upper income players jointly control	25 units
economic actors jointly control	25 units
Total	100 units

Thus, if there were two low income players in the game, one was assigned 12 units of political power and the other was assigned 13 units; if there were three low income players, two were assigned 8 units and one was assigned 9 units; etc. Similarly, if there were three economic actors in the game, two were assigned 8 units and one 9 units, etc.

Rules for Politicians: The political players were initially assigned equal amounts of power. Thus, if there were five political players, each initially received 20 units of political power; if there were six players, four players initially received 17 units, and two players initially received 16 units, etc. The total 100 units of power were redistributed during elections according to the votes of the community players. Such elections were held every five rounds, taking place before rounds 6, 11, 16, etc.

With these power units, the political players attempted to spend all or part of their 5-round budgets. These budgets could only be spent on locating bonus chips on the game board in whatever cells the political players could agree upon.

At the start of the game and immediately following elections, the political players were given a budget of 10 millobucks to spend within a five round period. Budget surpluses (millobucks not spend during the 5 rounds) were not carried over to the next period. The budget could be spent as follows:

(a) Each residential service bundle bonus chip cost 1 millobuck and increased the residential points in the cell in which it was placed and in the 8 surrounding cells by +3 points. (Examples of residential service bundle bonus chips might be improved neighborhood parks, lighting, sewage and waste disposal service, schools, roads, and health facilities.)

(b) Each economic area improvement bonus chip cost 5 millobucks and increased the economic points in the cell in which it was placed and in the 8 surrounding cells by +15 points. (Examples of economic area improvement bonus chips might include downtown lighting and tree planting, public parking garages, industrial park development, and improved shopper transportation services.)

(c) Each special project bonus chip cost the entire budget of the 5 round period (i.e. 10 millobucks). There were three types of special projects which could be implemented:

(1) New sports complex: A multi-structured complex, including a football stadium and an arena, and requiring extensive parking facilities and access routes. It could be located anywhere on the game board. Each economic player would receive a bonus of 50 points (in addition to the board points) for locating one of his chips in the same cell or in one of the eight surrounding cells to the complex site. Only one bonus could be earned by any player. The complex development had an adverse effect on residences: the residential values of the cell in which the complex was located and the eight surrounding cells were decreased by 10 units for the remainder of the game.

(2) Public rapid transit system: A linear or zig-zag system covering nine contiguous cells anywhere on the game board. It had the affect of increasing the economic value of the nine cells along the route by 25 units each and all the residential values along the route by 5 units each.

(3) Elevated express highway: A linear or zig-zag system covering nine contiguous cells anywhere on the game board. It benefitted the population at both ends, but detracted from the residential value of the areas through which it passed. It had the affect of increasing the residential value of the two end cells and the ten peripheral surrounding cells (five around each of the two end cells) by 5 units and the economic value of these same 14 cells by 25 units. Furthermore, it depressed all the residential values of the seven cells along the route but not end cells by 10 units each.

In order to spend all or part of the budget, the political players had to accumulate at least 60 power units in favor of the action. This was accomplished in the following manner: A political player recommended some action for discussion and voting. Discussion occurred followed by a hand vote. The political players could use all or part of their assigned power units in the vote. If at least 60 votes were in favor of the action, it carried, and was immediately enacted.

The objective of the game for the political players was to earn as many power units as possible during the elections held each 5 rounds. In addition, the players could earn additional "success points" by achieving certain political objectives known only to them (and explained below and on the individual game role sheets).

Election Procedure:

The election procedure was as follows:

(a) An election took place every 5 rounds, beginning before round 6.

(b) Each of the community players introduced himself, revealed the number of power units he controlled, and stated his demands of the political players to secure his vote.

(c) The political players then responded by introducing themselves, revealing the number of power units they presently were assigned, describing past performance, and listing their promises if given votes. (They were free to slander their fellow political players if they were so inclined.)

(d) The community players then delegated in turn their power units to one or more political players for use during the next 5 rounds (that is, if a player had 10 power units to assign, he could give all 10 to one player; 6 to one player and 4 to another; etc.)

(e) The low income players had a further option open to them. If they did not wish to support any political player, they could assign their votes to the "riot box." They were also at liberty to assign part of their political units to one or more political players and part to the "riot box."

Rules Governing Riots: When at least 20 power units had accumulated in the "riot box," a "riot" occurred as soon as the low income players could demonstrate that a majority of them favored a "riot."

The consequence of a "riot" was that 3 millobucks from the current budget were turned over to the low income players for use as they saw fit, and 2 additional millobucks were lost from the total budget for the next 5 rounds (to represent a city-wide economic and social loss as a result of the riot). The low income players had to have a majority consensus among themselves (that is, at least 13 power units of the 25 held jointly by these players) before they could spend these 3 millobucks.

Specific Player Objectives: In addition to the general game objectives as stated above, both the community players and the political players were given specific objectives to attempt to achieve during the game play. Examples of these follow:

1. Upper income resident A loses 2 points for every middle income chip located in the same cell or in the next cell to any one of his chips. Thus his specific objective is to "stay clear" of middle income chips.

2. Lower income resident B is anxious to move into a middle class area. This is expressed by his winning 2 bonus points for every middle class chip in the same cell or next to one of his chips.

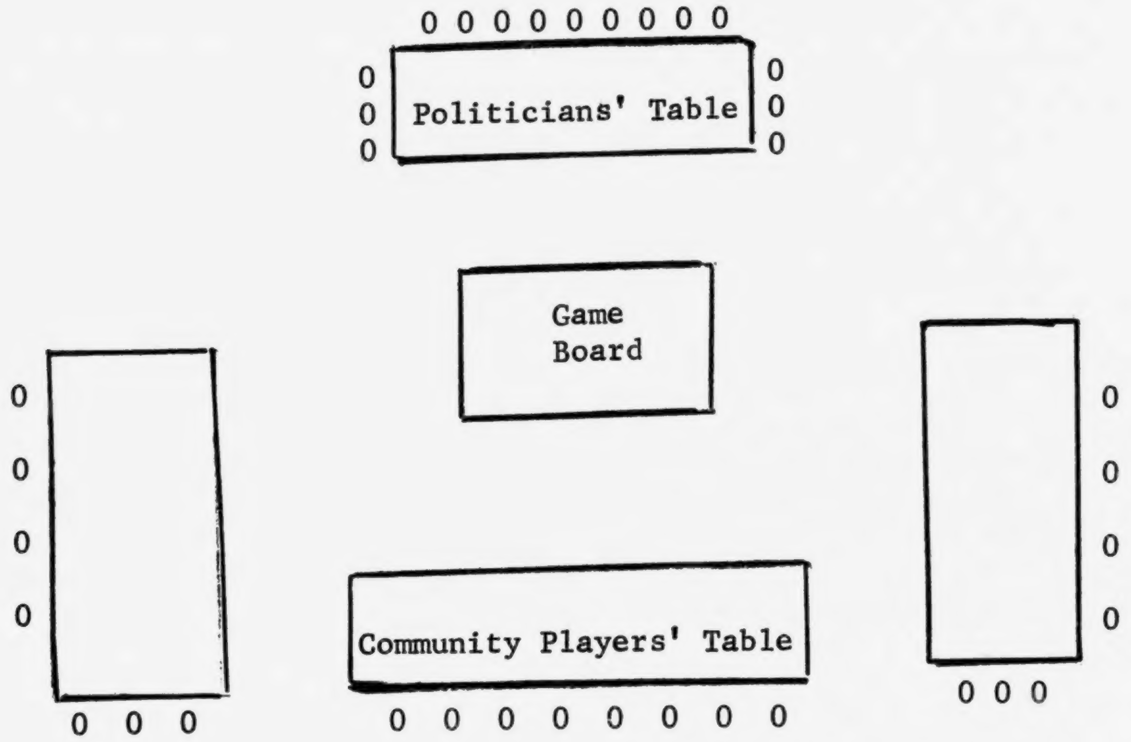
3. Conservative political player C wishes to maintain the status quo. That is, he wants to see the low income chips kept out of middle income areas. He loses 4 "success units" for every low income chip in the same cell as a middle income chip.

4. Radical political player D wishes to disrupt the political process. He receives 1 "success unit" for every millobuck not spent plus 5 "success units" for every riot occurring.

Time and Player Requirements: Each round lasted for no more than 5 minutes. Between 15 and 20 minutes were reserved for each election. Thus, three hours in total was needed to explain the rules and play a complete game of 20 rounds. It was highly desirable for players to participate in LOC-5 at least twice, once in a community player role and once in a political player role.

A minimum of 12 players were needed to play the complete game (2 in each of the 4 community roles and one in each of the 4 political roles), plus two game controllers. As many as 24 players could be accomodated, with a recommended distribution being 2 players for each of the four political roles and 4 players for each of the community roles.

The game room configuration utilized was as follows:



Concluding Remarks

As should be apparent, the LOC-games can readily be adapted to fit most existing political structures, and the hidden board values can be selected so as to simulate - at least in a rough fashion - any urban area. As such, the series is potentially very useful as a training device.

The extensions of the LOC-games into other related areas such as Model Cities planning have in some cases already been accomplished - at least in a preliminary way. Further adaptations will be made as demands so indicate and research time permits.

"THE CONNECTICUT GAME"

Dennis Little
Institute for the Future

THE CONNECTICUT GAME

Dennis L. Little
The Institute for the Future

Introduction

The Connecticut Game was developed by the Institute for the Future under a grant from the Connecticut Research Commission. The research conducted under this grant included forecasts of technological and social changes, and identification of prospective issues and opportunities for Connecticut. The results of this research provided the material for the Connecticut Game. The game model simulates the process and effects of state planning in Connecticut over ten-year intervals--1970-80, 1980-90. It is a state decision-making model. The game was run at a simulation conference held June 6 and 7, 1969, at the IFF offices in Middletown, Connecticut.

This paper describes the objectives and design of this game. It also attempts to analyze the game's successes and failures, and to assess its future utility. IFF Report R-9 describes this work in more detail.[1]

Objectives

The objectives of the Connecticut Game were to test and refine methods that could ultimately be used to:

- Analyze the effects of external (world and national) technological and societal developments and of alternative courses of action (policies) on the state.
- Provide a better understanding of the roles of governmental decision-makers and the elements of society affected by their decision.

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[1] Selwyn Enzer, Theodore J. Gordon, Richard Rochberg, and Robert Buchele, A Simulation Game for the Study of State Policies, IFF Report R-9 (The Institute for the Future, September 1969).

- Generate discussion which would lead to a better understanding of the state's future needs and opportunities and wider recognition of the alternative courses of action available to the state.

Game Design

The participants in the game were divided into three groups. Group Three, called evaluators, simulated society-at-large. The basic task of the evaluators was to record society's degree of satisfaction with the state of affairs in Connecticut. Each member of the evaluating team represented a certain segment of society: the urban poor, the cultural elite, the middle class, the older citizens, youth, city management, the financial community, and the federal government. Role-playing was used to encourage explicit consideration of the interests of these sectors of society.

Groups One and Two represented legislators. One legislative team was instructed to develop a program of legislation to maximize the per capita gross state product (GSP), and the other to optimize the Connecticut quality of life (QOL). The general game flow is shown in Figure 1.

The game began with the evaluators discussing their satisfaction with 14 social and economic indicators:

1. Government Effectiveness
2. Business Climate
3. Housing
4. Transportation
5. Satisfaction with the Tax Structure
6. Employment
7. Standard of Living
8. Social Climate
9. Control of Crime
10. Physical Environment
11. Health
12. Education
13. Recreation
14. Personal Liberties

In addition, they assessed two aggregate indicators--GSP per capita and Connecticut QOL. They used a scale ranging from 20 (crisis situation) to 100 (excellent situation), as shown in Figure 2.

Each player heard (and may have contributed to) the evaluator's discussion of the current state of each indicator and thus gained some

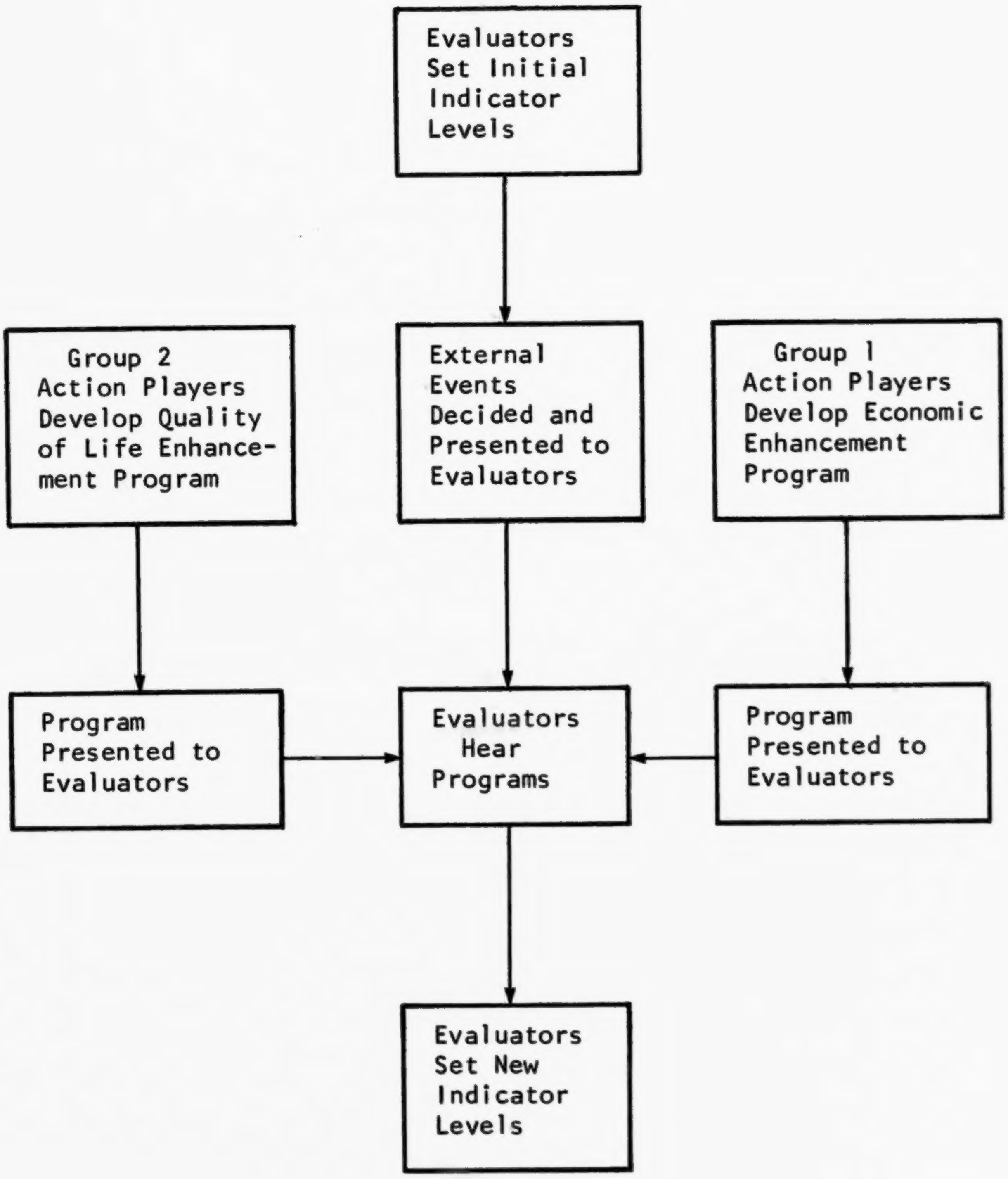
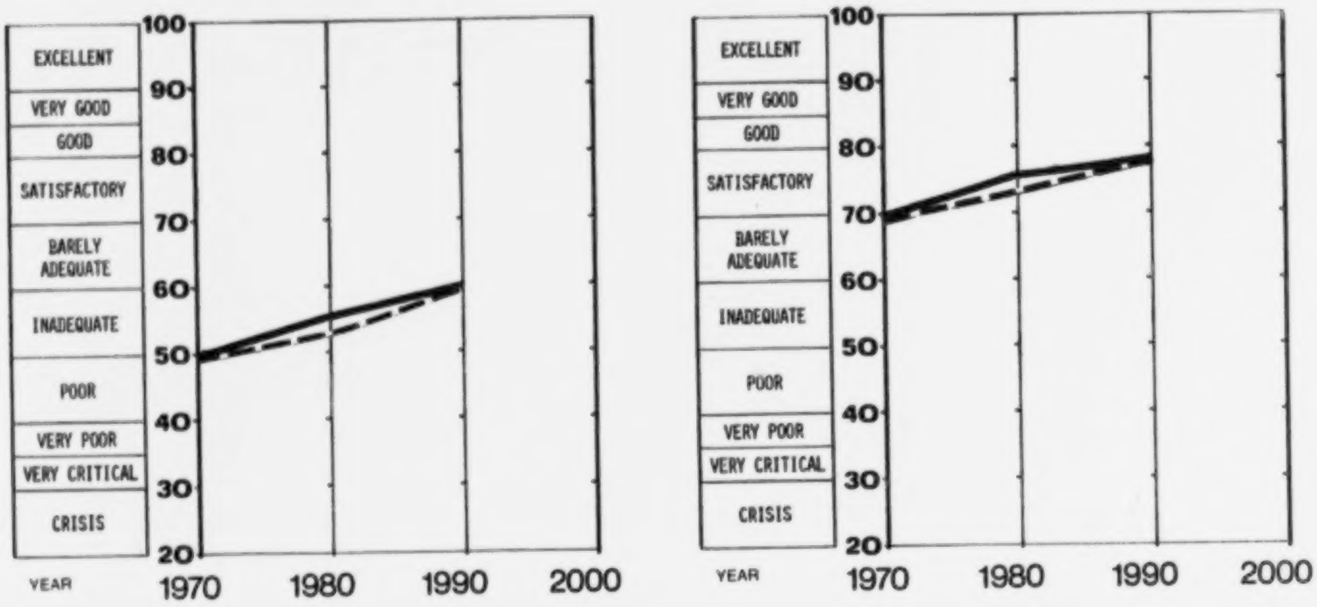
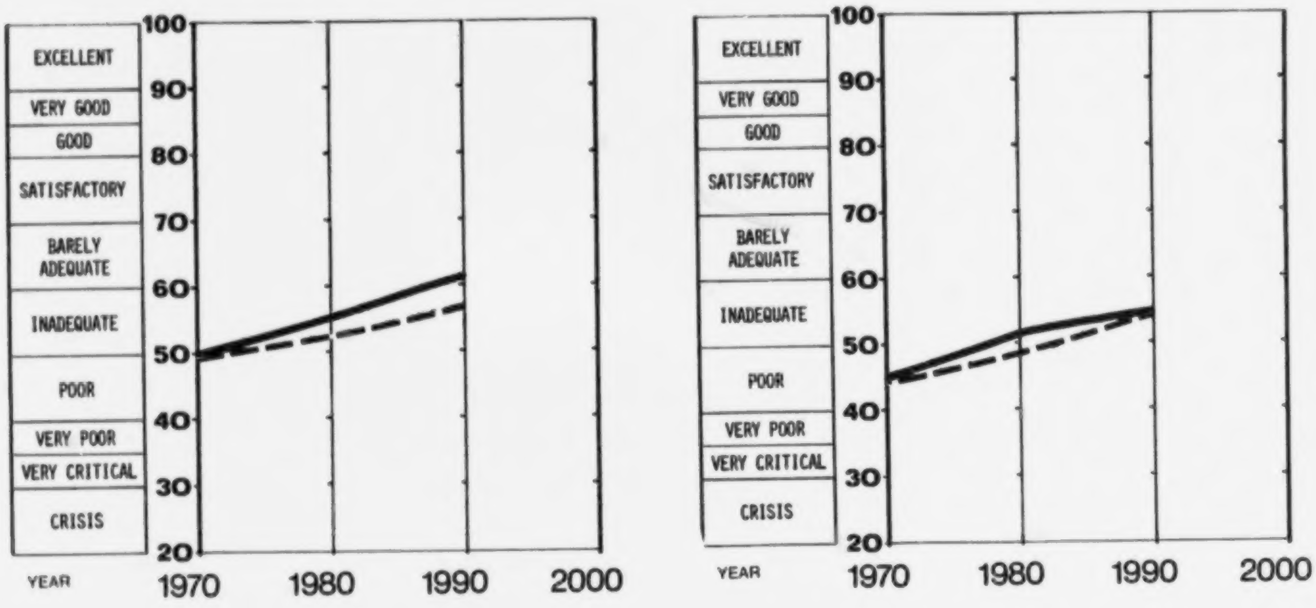

Evaluators Set Initial Indicator Levels
Group 2 Action Players Develop Quality of Life Enhancement Program
External Events Decided and Presented to Evaluators
Group 1 Action Players Develop Economic Enhancement Program
Program Presented to Evaluators
Evaluators Hear Programs
Program Presented to Evaluators
Evaluators Set New Indicator Levels

FIGURE 1. GENERAL GAME FLOW



1. Government Effectiveness

2. Business Climate



3. Housing

4. Transportation

FIGURE 2. SAMPLE INDICATOR DISPLAYS

insight into the criteria used in the evaluating team's assessment. The evaluators voted on the indicator levels.

Each legislative team was provided with a set of candidate action cards derived from the IFF Delphi study of future issues and opportunities described in IFF Report R-8.[2] On each card was a potential action and a brief discussion of its concepts. In addition, each card listed the suspected impact of the action on each of the 14 indicators, and the minimum cost. A typical action card is presented in Figure 3.

An economic system was superimposed on the play to limit the number of actions the players could choose and to force consideration of priorities. Generally, the price of an action was taken to be an intuitive measure of political difficulty and fiscal costs required to establish a program that would have a noticeable impact on the state. The most expensive action cost 10 points, the least, 1 point. Each legislative team had 60 points to spend in the first decade, and each action had to be allocated at least its minimum price. Total expenditures had to be within the budget, and the players were not allowed to increase their budgets in subsequent periods by raising taxes. No distinction was provided in the budget between the obstacles of cost and social or political difficulties.

Each team was encouraged to consider not only the alternative actions presented on its set of cards, but also to propose new ones. Several were proposed. They were approved and costed by the evaluators.

The legislators were told that the programs they were preparing were in addition to the normal operation of the state. For example, if no action were taken in the area of education, this would not have meant that schools would be closed or even that the normal rate of school construction would be slowed.

Future events and developments external to Connecticut were introduced into the game since they will also have an important impact on the economy and social well being of the state. Fifty potential external developments were selected from technological and social Delphi studies conducted at IFF. Each event was presented on a card and in the form of a cross-impact matrix, which indicated its probability of occurrence with the expected linkages of interdependencies among events. Events were chosen at random from the list of fifty, and

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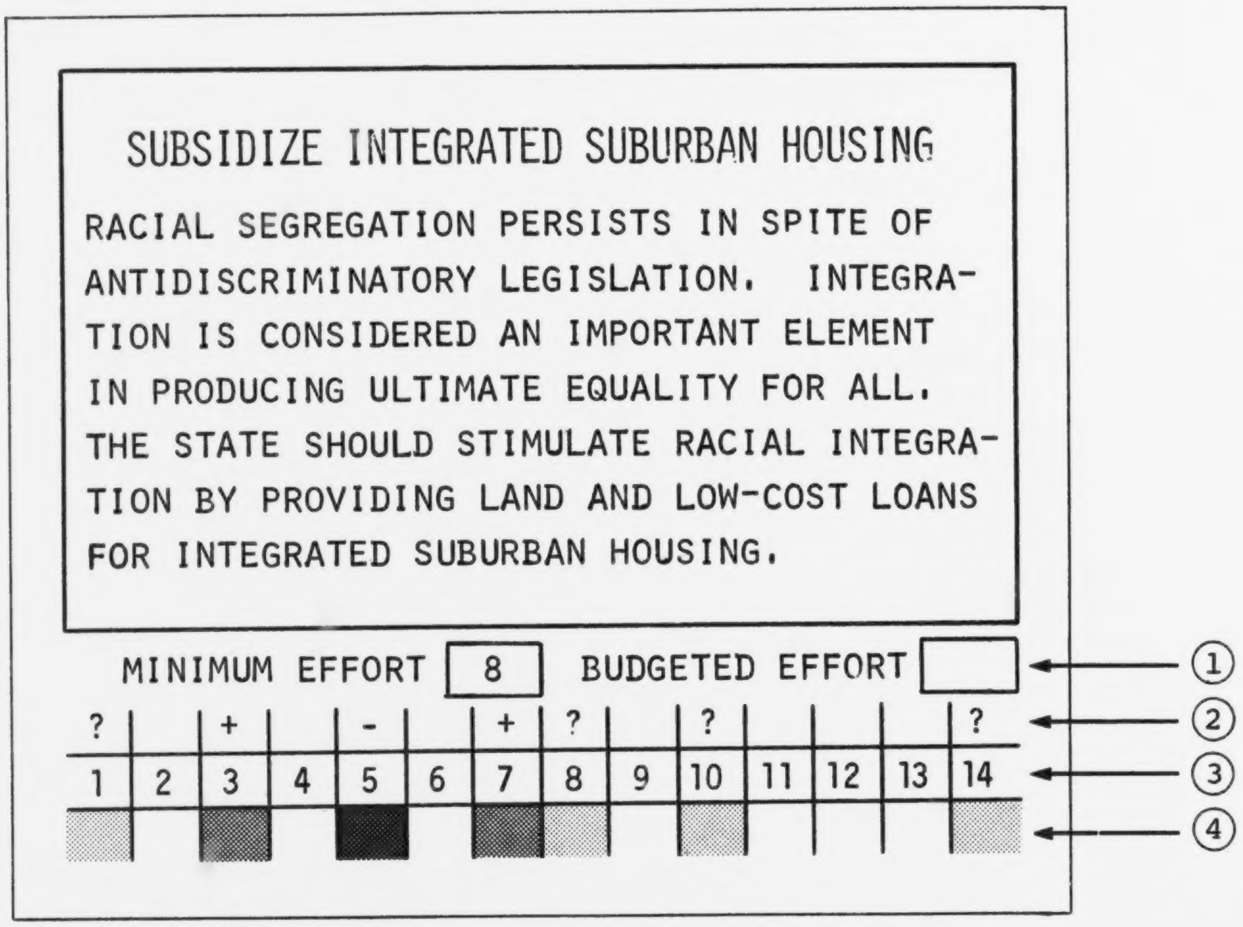
[2] Selwyn Enzer, Raul de Brigard, Issues and Opportunities in the State of Connecticut, IFF Report R-8 (The Institute for the Future, March 1970).



SUBSIDIZE INTEGRATED SUBURBAN HOUSING

RACIAL SEGREGATION PERSISTS IN SPITE OF ANTIDISCRIMINATORY LEGISLATION. INTEGRATION IS CONSIDERED AN IMPORTANT ELEMENT IN PRODUCING ULTIMATE EQUALITY FOR ALL. THE STATE SHOULD STIMULATE RACIAL INTEGRATION BY PROVIDING LAND AND LOW-COST LOANS FOR INTEGRATED SUBURBAN HOUSING.

MINIMUM EFFORT 8 BUDGETED EFFORT ☐

?		+		-		+	?		?				?
1	2	3	4	5	6	7	8	9	10	11	12	13	14
░		▒		▓		▒	░		░				░

KEY:

① Assigned budget level (not less than minimum)

Suspected indicator impacts (see page 8):

② + = probable improvement
  - = probable degradation
  ? = likely to vary with societal sectors

③ Indicator number

④ Color code for easy identification of suspected impact

FIGURE 3. TYPICAL ACTION CARD

their occurrence during the interval being simulated was "decided" by comparing their probability of occurrence as determined from the Delphi study with a random number obtained by casting die. If an event was said to have happened, the probabilities of the other events happening were adjusted according to instructions contained in the matrix. A typical event card is shown in Figure 4 and Table I illustrates the probability of occurrence of external events.

Events determined to have happened were described to the evaluators while the legislative teams were developing their programs. The evaluators were to consider these events later when they assessed new values of the social indicators.

Although group competition was not intended as an element of the game, the two legislative teams competed in the sense that the impacts of their decisions on the indicators were compared, allowing an evaluation of the relative success of different governmental policies. Actions selected by each team are shown in Table II.

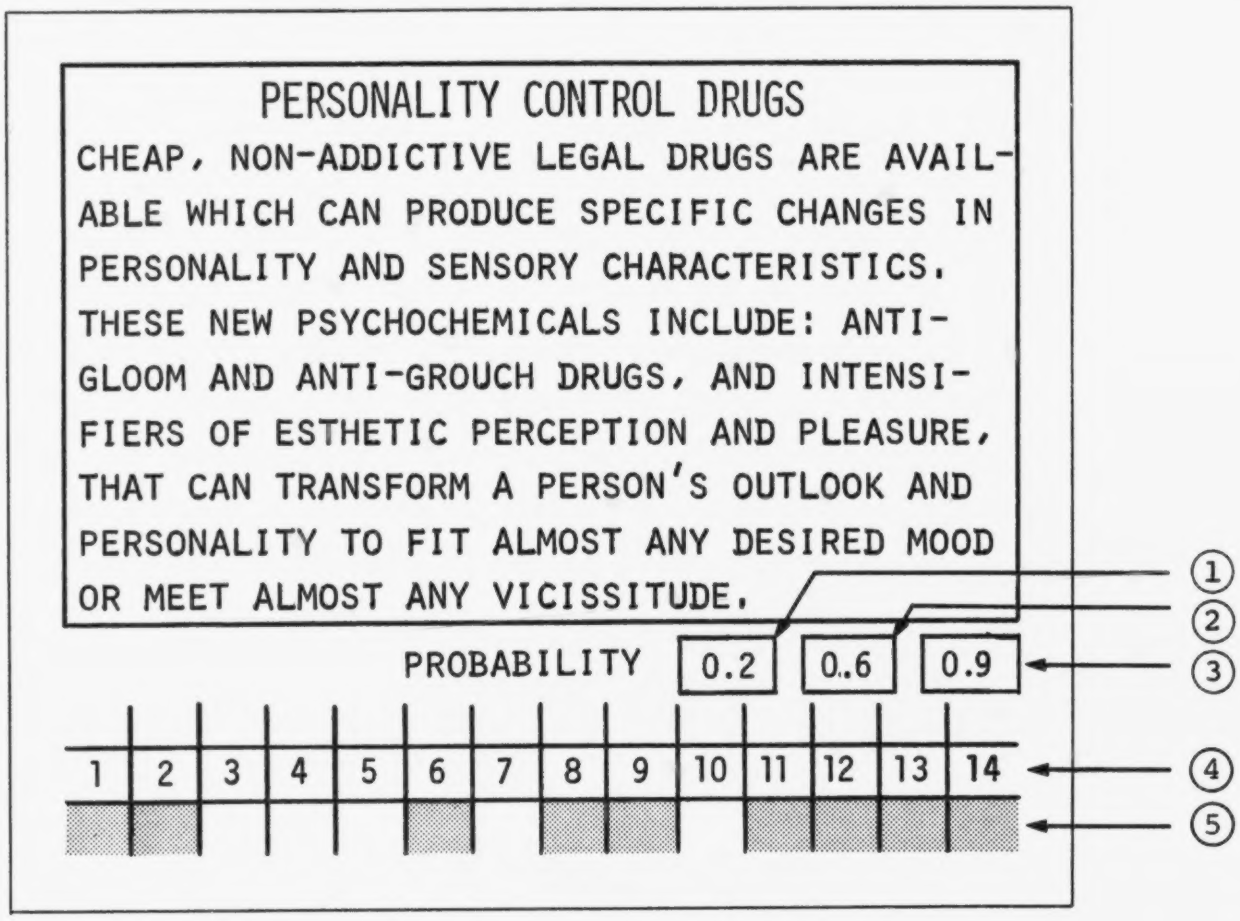
After the teams had developed their programs, the evaluators were briefed on the actions taken and the indicators were reassessed for 1980. The evaluators considered how the indicators might be affected from the point of view of the social sector they were simulating. This assessment again involved debate which centered around recognition of pluralistic social interests and the likely effects of external social and technological change. Once this had been accomplished, the cycle was repeated for the next decade.

Simulation Results

When the final round was completed, the indicator satisfaction levels were set and the results of the game were reviewed. The final results and the interim levels are shown in Table III. In interpreting these indicator values it must be remembered that the evaluators, in role playing had to produce ratings based upon a potentially highly-biased and unrepresentative sample of the Connecticut population.

Several observations can be made from the indicator values. First, they are low. While there was general agreement among the players that Connecticut compares favorably with the rest of the United States, the low ratings apparently stemmed from the differences between the achievements of the state and the expectations and aspirations of the evaluators.

Second, the QOL indicator is higher than the average of the 14 others, showing that the evaluators considered some indicators more



PERSONALITY CONTROL DRUGS

CHEAP, NON-ADDICTIVE LEGAL DRUGS ARE AVAILABLE WHICH CAN PRODUCE SPECIFIC CHANGES IN PERSONALITY AND SENSORY CHARACTERISTICS. THESE NEW PSYCHOCHEMICALS INCLUDE: ANTI-GLOOM AND ANTI-GROUCH DRUGS, AND INTENSIFIERS OF ESTHETIC PERCEPTION AND PLEASURE, THAT CAN TRANSFORM A PERSON'S OUTLOOK AND PERSONALITY TO FIT ALMOST ANY DESIRED MOOD OR MEET ALMOST ANY VICISSITUDE.

KEY:

Probability of occurrence as determined
by Delphi study during decade of:

① 1970-1980
② 1980-1990
③ 1990-2000

④ Indicator number (see page 8)

⑤ Suspected (nondirectional) indicator impact

FIGURE 4. TYPICAL EVENT CARD

TABLE I: PROBABILITIES OF OCCURRENCE OF EXTERNAL EVENTS

	EXTERNAL EVENTS	Probability of Occurrence in the 1970s	Occurred in the 1970s	Probability of Occurrence in the 1980s	Occurred in the 1980s
1.	MULTI-STATE REGIONAL AUTHORITIES	.80	yes	.90	yes
2.	AVERAGE RETIREMENT AGE: 55	.10	yes	1.00	
3.	ADVANCED BUILDING CODES	.60		.80	yes
4.	NUCLEAR DISARMAMENT	.20		.55	
5.	BIOLOGICAL WEAPONS	.30		.20	
6.	WARS NOT DIRECTLY INVOLVING THE UNITED STATES	.80	yes	.80	
7.	LIMITED WARS DIRECTLY INVOLVING THE UNITED STATES	.30		.35	
8.	CREDIT CARD ECONOMY	.70		.85	yes
9.	BUSINESS RECESSION	.20		.30	
10.	CONTINUED INFLATION	.60	yes	.45	yes
11.	EDUCATIONAL NETWORK	.30		.45	
12.	DATA BANKS	.60		.70	yes
13.	HOUSEHOLD ROBOTS	.20		.40	
14.	THIRTY-FIVE HOURS WORKED PER WEEK	.30		.55	
15.	HIGH I. Q. COMPUTERS	.30	yes	1.00	▬
16.	BEHAVIOR CONTROL	.20	yes	1.00	▬
17.	CHEAP POWER FROM CONTROLLED THERMONUCLEAR POWER	.10	yes	1.00	▬
18.	LIMITED WEATHER CONTROL	.30		.50	yes
19.	ANTI-SMOG DEVICES	.20		.65	yes
20.	HIGH SPEED MASS TRANSPORTATION	.10		.65	
21.	HYPERSONIC TRANSPORT	.00		.20	
22.	AGING CONTROL	.10		.15	
23.	SEX CHOICE	.20		.45	
24.	PERSONALITY CONTROL DRUGS	.20		.55	yes
25.	RELATIVE DECREASE IN THE DEFENSE BUDGET	.10	yes	.65	yes
26.	MASS PRODUCED HOUSING	.40		.75	yes
27.	URBAN RIOTS	.20		.20	
28.	EUROPEAN SST	.30		.30	
29.	NASA BUDGET CUT	.20	yes	.20	
30.	OCEANOGRAPHY PROGRAM	.20		.50	
31.	INCREASED CRIME	.30		.50	
32.	NEW CITIES PROGRAMS	.20	yes	.60	yes
33.	NEGATIVE INCOME TAX	.40		.55	
34.	EXTENDED VACATIONS	.00		.20	yes
35.	MULTI-HOME FAMILIES	.10		.25	yes
36.	WOMEN IN THE LABOR FORCE	.30		.30	
37.	NEGRO POLITICAL CONTROL OF CITIES	.50	yes	.40	yes
38.	NEW FAMILY ARRANGEMENTS	.05		.10	
39.	EXPANDED FEDERAL WELFARE PROGRAMS	.20	yes	1.00	▬
40.	LEISURE EXPENDITURES DOUBLE	.40	yes	.60	yes
41.	GENERAL IMMUNIZATION	.20		.50	yes
42.	MORE AUTOS PER FAMILY	.20	yes	1.00	▬
43.	AUTOMATED PURCHASING	.30	yes	1.00	▬
44.	LOW COST PORTABLE TELEPHONES	.00		.10	
45.	GROWTH OF AIR TRAFFIC	.10		.30	yes
46.	ABANDONMENT OF LOW STATUS JOBS	.40		.40	
47.	DECREASE IN TOBACCO CONSUMPTION	.30		.50	yes
48.	LIMITED GENETIC CONTROL	.00		.10	
49.	AUTOMATED PLEBECITE	.00		.10	
50.	GROWTH OF PUBLIC SERVICE PROFESSIONS	.20		.20	

KEY: "yes" = Event occurred in decade shown.
▬ = Event occurred in the previous decade and had sustained effects.

TABLE II: ACTIONS SELECTED IN TWO ROUNDS OF PLAY

ROUND ONE: 1970 - 80

GSP TEAM			QOL TEAM		
No.[1]	Action Title	Minimum Effort[2]	No.[1]	Action Title	Minimum Effort[2]
1	Implement community development programs on a regional basis	3	4	Centralize public service and facility districts	3
7	Offer incentives to high technology industry for migrating to Connecticut	4	5	Establish statewide regional governments	8
17	Reform building codes to accept technological innovation	4	7	Offer incentives to high technology industry for migration to Connecticut	4
19	Subsidize low-income housing	7	15	Place building code control at the State level	5
22	Establish new communities in rural areas	5	45	Initiate a State income tax[3]	2
41	Provide incentives for urban mass transportation systems	4	81	Extend the educational period	8
45	Initiate a State income tax	2	89	Enlarge vocational training programs	4
53	Subsidize new businesses for locating in the ghettos	2	204	Establish a State new community development corporation	8
79	Offer adult educational retraining	3	205	Collect all taxes at the State level	3
82	Institute high school work-study programs	3	210	Offer subsidies for the creation of new categories of service employment	3
89	Enlarge vocational training programs	4	212	Reconstruct public education system	8
90	Offer compensatory payment for scholastic achievement	3	214	Enlarge educational opportunities for adults	3
201	Construct a new airport in eastern Connecticut	5			61
203	Provide free post-secondary education for all students	5			
209	Keep schools open evenings and weekends	4			
210	Offer subsidies for the creation of new categories of service employment	3			
		61			

ROUND TWO: 1980 - 90

No.[4]			No.[4]		
3	Institute a statewide government data management system	3	1	Implement community development programs on a regional basis	3
4	Centralize public service and facility districts	3	2	Establish an ombudsman's office	1
12	Make multiple use of highway space	1	14	Rezone to decentralize urban areas	5
30	Provide mass parking facilities around urban perimeters	4	60	Upgrade educational requirements for police	2
52	Offer bonuses to welfare recipients who become self-supporting	3	62	Increase penalties for selling drugs	1
58	Provide free day-care for children up to age fourteen	3	63	Require registration of firearms	4
66	Increase taxes on property use obstructive to regional development	3	70	Encourage health insurance programs which maximize efficiency in medical services	2
71	Offer incentives for development of a system of echelon hospitals	3	72	Provide computer services for medical diagnostics	3
77	Improve educational TV programs	2	99	Provide more State parks	3
79	Offer adult educational retraining	2	101	Provide community recreation facilities	3
84	Acquire and use teaching machines	4	105	Provide free transportation to recreational facilities for ghetto residents	1
90	Offer compensatory payment for scholastic achievement	3	304	Provide incentive for development of computerized at-home instruction	2
99	Provide more state parks	3	305	Establish quasi-public corporation to encourage new manufacturing businesses based on technological innovation	1
103	Perform research on innovative technology for creating recreational facilities	1	308	Subsidize groups or corporations which develop leisure time products	2
105	Provide free transport to recreational facilities for ghetto residents	1	311	Lower voting age to 18	1
302	Construct a deep-water port in Long Island Sound near New Haven	3	312	Construct and lease housing (lease to cover cost of services and maintenance)	3
303	Encourage establishment of new rural and urban communities	7	318	Develop transportation system to enable young, poor, old to get to leisure areas	4
304	Provide incentive for development of computerized at-home instruction	2	320	Expand State highway system	5
305	Establish quasi-public corporation to encourage new manufacturing businesses based on technological innovation	1	322	Develop two new major airports with complete new communities (including employment opportunities)	8
306	Restructure public education to make program more relevant	6	323	Eliminate substandard housing through acquisition and demolition or restoration	3
308	Subsidize groups or corporations which develop leisure time products	2	328	Develop new underground drilling techniques	2
309	Initiate system of fines which would make air and water pollution uneconomical for polluter	3	331	Intern field training programs for government personnel	2
		63	332	Make Connecticut the national data-bank center	4
					65

[1] Actions numbered 1 - 111 were provided in the prepared deck. Actions numbered in the 200's are new actions proposed by the teams in the first period.

[2] Each team had a budget of 60 points for the first decade. Both the Green and the Buff programs sum to 61 effort points due to an accounting error which was not discovered until after the programs were evaluated.

[3] This is the only action of the entire game which was budgeted at more than minimum cost; it was budgeted at a level of 4.

[4] Actions numbered in the 300s are new actions proposed by the teams in the decade of the 1980s.

TABLE III: INDICATOR SATISFACTION LEVELS

INDICATOR	Initial Value (1970)	GSP TEAM				QOL TEAM			
		Changes in 1970s	1980 Value	Changes in 1980s	1990 Value	Changes in 1970s	1980 Value	Changes in 1980s	1990 Value
1. Government Effectiveness	50	6	56	4	60	4	54	5	59
2. Business Climate	70	5	75	3	78	4	74	4	78
3. Housing	50	5	55	6	61	2	52	5	57
4. Transportation	45	6	51	3	54	4	49	5	54
5. Satisfaction with Tax Structure	40	-1	39	0	39	-2	38	0	38
6. Employment	70	4	74	4	78	2	72	3	75
7. Standard of Living	65	4	69	4	73	2	67	4	71
8. Social Climate	50	4	54	2	56	1	51	4	55
9. Control of Crime	40	2	42	2	44	2	42	4	48
10. Physical Environment	65	4	69	4	73	2	67	5	72
11. Health	60	2	62	6	68	2	62	5	67
12. Education	50	6	56	6	62	4	54	4	58
13. Recreation	60	1	61	4	65	0	60	8	68
14. Personal Liberties	60	0	60	-2	58	0	60	1	61
Quality of Life	60	6	66	3	69	2	62	4	68
Gross State Product per Capita	$5000	$500	$5500	$500	$6000	$200	$5200	$600	$5800

important than others and therefore gave their contribution to the quality of life greater weight. Additional runs and some restructuring of the game will be necessary to determine how much weight is given each indicator, and if the weights represent the views of the evaluator or the views of the person he is simulating.

The third result, while it doesn't necessarily correlate to the real world, is, nevertheless, quite interesting. The legislative team whose goal was to increase the GSP also significantly affected the QOL. At the end of the game, the GSP team's policies had increased the GSP and the QOL to a level higher than the level achieved by the QOL team.

Analysis

In reviewing the run of Connecticut Game, the IFF staff discovered that the programs developed by the legislative teams placed emphasis in unexpected areas. Two of these areas were taxes and control of crime.

According to the rules of the game, it was not possible to raise revenue from taxes to increase the available budget. Hence, neither team was expected to introduce any new taxes. However, both teams initiated a state income tax as part of their list of actions for the first round of the game. Although this decision is hard to understand in the context of the simulation, it is not hard to understand in the context of Connecticut. The subject of a state income tax had been vigorously debated in the state legislature and the media during the week preceding the run of the game.

Law and order was also an active political issue at the time the game was played, and the evaluators set the Control of Crime indicator at 40, one of the lowest settings. However, the teams took almost no action in this area until the second round. It is not clear why this happened, but possible reasons are that not many actions existed in this area in the prepared list, or that the teams felt that the evaluators had not reached a consensus as to what type of action should be taken.

It was perhaps inevitable that the initial run of the game had many problems involving both the details and the general game concept. The most serious of these are mentioned below.

The evaluators had an opportunity to discuss the external events that happened during each decade in some depth and to consider the impact these events would have both on society and on each indicator. Unfortunately, the legislative teams had neither the opportunity for such a discussion nor an opportunity to hear the conclusions that were reached by the evaluators. Thus the players were never as informed as they should have been about the extent and manner in which the external events were determining the indicator changes, while the evaluators felt that the external events were a major influence. Additional runs of the game coupled with additional staff analysis will probably resolve this problem.

Another difficulty encountered by the participants and also the designer was the complex and occasionally ambiguous relationship between federal, state and local governments. Because of this difficulty, it was never clearly established whether the indicators applied solely to Connecticut or to Connecticut in comparison with the country as a whole. For Personal Liberties and some other indicators, the evaluators appeared to be rating the national rather than the state situation.

Future Use

Despite its problems, the game was viewed as a success by the staff of the Institute and the game participants. It did not provide a significant forecast of the future of Connecticut, but the game did demonstrate that the format could serve as a teaching tool, promote communication between players, provide an orderly framework for the consideration of alternative potential political actions and spark debate on issues of concern to various sectors of society.

With some modification, research, and of course, financing, the game could be run again as an instructional device and/or as a state decision-making model. As a state decision-making model, it has applicability and utility for planners in any of our state governments.

"FUN CITY: AN URBAN PLANNING GAME"

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FUN CITY: AN URBAN PLANNING GAME

K. Michael Burke and David Seader

Introduction - Image of the Urban Planner

Historically, an urban planner has been primarily concerned with the physical and visual composition of a city. The brunt of his efforts to effect change was directed at land use, buildings and concepts of open space. Now, however, the field of urban planning is becoming increasingly social, economic, and political in nature. Many new planners are moving in directions largely unfamiliar to the early history of their profession.

As a result, one of the foremost problems facing the new urban planners is that of finding themselves a effective position and of using that position to influence and direct change. At present, the typical urban planner in the United States has neither the position nor the power to effectively tackle the wide scope of problems with which he is concerned. He has to find his place within the city's power structure.

The most influential actors in the city operate from power bases to achieve objectives important to them. Interest groups may operate from similar or different power bases, and their goals may be similar to, conflicting with or unrelated to each other. The decisions affecting the city's operation result from the interworkings of these groups. These power alliances, conflicts and overlaps form the working environment for the urban planner. But a planner, until he can find an opening for himself in this sphere, does not realistically play an important part in the city's decision-making process. The game does not, therefore, place him unrealistically into the environment, but familiarizes him with the atmosphere with which he has to contend.

Even if the planner is successful in finding his position, it is highly unlikely that he will be able to command enough power to dictate solutions. He must, therefore, be able to use what limited power he can muster as efficiently as possible if he is to attain his objectives. He must be able to skillfully manuever and/or manipulate those with power who are working towards individual ends. He can either cooperate with these forces, compete against them, or attempt to change their directions. This requires on the part of the planner a thorough understanding of and appreciation for individuals with different and often counter-productive goals. He must understand how and where their various motives can be directed towards planning ends, and he must be able to compete for resources and influence the actions taken by others. The ability to balance efforts between cooperation and competition, and to determine where an attitude change is desirable requires skill at interpersonal dealings. This aspect of a planner's education is often lacking in formal planning curricula. This is also the area of planning education that the designers of Fun City had in mind as they developed the game's educational goals.

Purpose and Goals of Fun City

The primary purpose of Fun City is to further the education of the players and overseers. The game provides an environment within which participants are encouraged to use and develop skills of interpersonal dealings pertinent to the role of a city planner as described above. It is not intended to further his skills in physical design or the use of technical tools. Transfer of specific facts and data, or accurate conceptions of the workings of the city are also not primary aims.

The game simulates a power struggle in a large central city. The participant in the simulation should gain some understanding of the different outlooks of the generalized interest groups represented in the system, and how the approaches of these groups are affected by their individual goals and power bases. Furthermore, he should be able to use the power that he has in the game as efficiently as possible in order to achieve the goals that are set for him. He can learn that with bargaining and persuasive skills he can maximize his power beyond its cash value on the market. The game is designed to give the player experience in a simulated situation which will help prepare him for the real world.

The goals of the game are to educate the player and to make the education applicable to the real world. In other words, the player should:

1. gain knowledge of the means whereby the power interests and goal-seeking of major actors in the city interact to affect decisions

2. gain understanding of how different power bases and goals motivate people differently

3. develop bargaining and persuasive skills and gain experience in using these skills to maximize the effectiveness of one's power base to achieve specific goals

4. apply, the sensitivity acquired to real-life city planning situations

Game Design Assumptions

Two major assumptions were made before undertaking the design of *Fun City*. These were that:

1. interest does intervene favorably between method and learning, and

2. reality in the model is necessary only insofar as it allows players to identify with their roles and makes it easier to transfer the knowledge gained through playing to real problems.

The first assumption states that interest is an integral part of the educational process. Vital to any argument justifying gaming for education is the ability of a gaming situation to create a high level of participation and involvement during playing. The proponents of gaming assume that there is a strong link between participation-involvement-interest and learning. Therefore, the argument goes, since games are able to inspire a high level of interest among the players, a situation highly conducive to learning is created.

The correlation between interest and learning is, although appearing obvious, remarkably difficult to document. The interest generated in games is, on the other hand, relatively easy to demonstrate. Players often spend hours without interruption involved solely with their role in a game, and are oblivious to distraction.

Much of this interest in gaming may be due to the "Hawthorne Effect". This theory states that the increase in interest or results in a new method or experiment is due to its uniqueness and novelty, and the enthusiasm of the administrators, rather than to the qualities of the method itself. As most of the new games are tested in a controlled and monitored atmosphere, the attitudes of the operators are important. The enthusiasm of these operators with their method tends to be contagious and increase the interest of the players.

It was, therefore, of prime importance that our game have an element of excitement and attraction. In other words, the game must be playable. Much of the work towards this end was accomplished in the game testing phases, where the extent to which competition, win-lose possibilities, and clear-cut achievement standards affecting the involvement of the players was investigated. If the game was uninteresting and did not attract players, the designers would have failed in an important aspect of the design.

The second assumption concerns the realism of the game model. In Fun City, the realism only provides an effective environment for interpersonal dealings and keeps those dealings related to city planning. Realism increases the personal involvement in role-playing, and so the model is realistic enough to assure that the players will accept the group dynamics as applicable to real urban situations. Perfect realism is, of course, impossible, and great efforts towards a perfect model are extremely difficult and costly in time and money. This work is, primarily interested in teaching students generalizations, and not specific characteristics of a situation. A game's utility rests not on the validity of the model, but in the participants' acceptance of its reality during play.

There is no reason for reality purely for reality's sake. Reality must be distilled not only to make the system manageable, but to make a game playable. Relationships had to be distorted, discarded or invented in order to allow for exiciting play or smooth operation. By stressing the importance of playability and limiting the extent to which reality is desirable, guidelines were established for achieving a balance between the two. Wherever a conflict between playability and reality was encountered, realism was sacrificed in favor of playability. Where no conflict existed, attempts were made to make Fun City as realistic as possible. The interests of playability were given clear priority in game design considerations.

Game Objectives

The goals for Fun City were refined into objectives on the basis of the assumptions concerning educational method and the reality-playability conflict. The resulting objectives are as follows:

1. The game should create a simulated environment where attention of the participants is focussed on exchange of power to achieve goals.

2. The game should maximize personal involvement and intellectual participation of the players.

3. The game should hold lasting interest for the players.

4. Increased skill at bargaining by the players should be realized in increased game benefits. There should be a direct relationship between the use of power, both formal (dollars, votes, etc.) and informal (persuasion), and ends gained.

Game Design Considerations

The overriding consideration in creating Fun City was that it should be engrossing for all the players. Many otherwise desirable features included in other games were sacrificed to achieve a game that is easily playable and exciting. To develop a game with these characteristics meant limiting the number of players, their scope of action, and their modes of behavior. A new system, only partially faithful to its real-world counterpart, replaced the complexity of the real analogue to the game. The approach throughout is to substitute a new complexity for the complexity of real life.

Underlying this approach is the replacement of real-life transactions with symbolic transactions. Wherever possible, complex real-life systems were capsulized into representative game mechanisms, such as the contract system, to Municipal Budget and the Crises. Many variables were reduced to a significant few. The result was that the important essence of the real-world transactions remained to make their impact on the game and its players, without the extreme detailing that would be necessary if everything were included. Many cumbersome mechanics were avoided in this way. The simulated system emphasizes types of interactions, rather than numbers or multiplicities of interactions. This design consideration is in keeping with Fun City's primary goal of eduction. The bare-boned structure that remained after the modeling process highlights the significant involvements of the symbolic roles and vehicles.

Even with the high degree of simplification that was necessary to emphasize the designer's goals, enough complexity remains to keep the game challenging and intellectually stimulating for the players. They must adapt to a system which only symbolically resembles the one in which they operate. In other words, they must assume completely their assigned roles in order to succeed. This leads players to develop a sensitivity for roles which may be unfamiliar to them, to learn how actors other than themselves work in the urban setting, and to see the effect their actions have on other players and the state of the city.

Specifically avoided was the proliferation of game devices and instrumentalities that would cloud the basic structure of the system. If players feel like cogs in a gigantic system, and they cannot discern immediately their effect on the city, then the spontaneity of good gaming is lost.

Description of Fun City

Fun City models the basic political and economic conflicts existing in the city today. To be sure, the easiest part of the modeling is reproducing the repetitive struggle for public office.

It is noteworthy that many planning games avoid this conflict which is at the very heart of the city's operations. Fun City places heavy emphasis on political struggle and maneuvering. Much of the action revolves around the fight for election and the ramifications thereof. The game was designed to accommodate the obvious correlation between the performance of city government and the interests and powers of those who run the government. In the form of a budget, the political players make available environmental improvements to the residents, stressing the fact that politicians reward those who reward them. The game takes a hard line on realpolitik to heavily emphasize the overwhelming influence of politics on the progress of the city. It is the resultant of all the political pushes and pulls that determines the state of the city. The planner's role, as has been mentioned previously, is to learn to play the game (the real one, that is) with the best of them.

Complementing the political operations is a simulated free housing market. The dual emphasis on municipal improvements and housing underscores the game's fundamental concern with environmental quality. By environmental quality, it is meant the sum of all those physical, social and economic amenities that make the city a more or less comfortable and enjoyable place to live. The major contributors to the quality of the environment, besides the individual residents himself, are the city government and the landlords-builders-developers. All of these significant aspects of the quality of life have been included in the game.

The game is non-physical, that is, it stresses amounts of things and not their spatial distribution. In addition, all the various mechanics and variables are measured through time to establish the dynamic nature of the changing urban environment.

The Setting of the Game

The setting of the game is a large central city with a population of 600,000. The population figure is not significant, as the other game aspects emphasize the character of the city. The city has two types of Residents, Low Income and Middle Income, each group played by one player. These Residents struggle with each other to wrest from the city government and the private market the larger share of the limited environmental resources. It is an economic struggle in the most basic sense. The two groups of Residents must use all the influence they can muster to control as much of the resources of the city as possible. An assumption of the game is that each Resident seeks to maximize his comfort and security, even at the disadvantage of his neighbor. The opportunity to cooperate rather than compete is left open to the Residents, but the emphasis is on their competition.

The government is represented by a single player who has a constant adversary trying to remove him from office. Thus the political struggle is firmly established. The two Politicians need the votes of the two groups of Residents in order to get elected at the biennial elections. They, therefore, try to influence the Residents' votes by providing and promising advantages. Much of the game's action is in this very struggle between the Politicians and the Residents, acting separately and together.

The other scene of combat is the Housing Market. The conflict here is between two Land Developers who attempt to outdo each other in amassing assets. Along with the internal fight between the two Developers, they each must contend with the Residents, who represent demand for their product. The resolution of the disparity between supply and demand contributes the other major generator of game action, in addition to the political scene. Of less importance is the relationship between the Politicians and the Land Developers, similar to their nebulous relationship in the real world. The Politicians must influence the Developers to provide the type of housing that would make their constituencies happy and the Developers must try to make the economic conditions of the city as favorable as possible. Their tools in this respect are limited, and imagination is called for to effect favorable changes. What results is an integrated set of interactions which combine to various extents to determine the state of the city. These interactions are illustrated in the Interaction Matrix (Figure 1).

The Mayor provides municipal amenities to the Residents, sets income tax rates for the Middle Income Residents, and allocates welfare to the Low Income Residents in return for votes and possible campaign contributions. He also approves building permits and sets real estate tax rates for the Land Developers in the hope of getting campaign funds in return. The Developers provide the Residents with housing and the accompanying building services in return for an agreed rent. Complexity results when several of these basic interactions are used simultaneously by the various players to manipulate things to their own advantage.

The main expressions of the game's state come about through the milieux of the game: The Mayor's budget, contracts, and leases. The Mayor exposes, through the budget, his decisions on distribution of income and expenses affecting all the other players, thereby expressing his preferences and prejudices. Contracts are used to formalize exchanges between two players, thereby tying them to certain policies and actions. Leases show how the Residents are being housed. These three milieux, the public leases and budget and the secret contracts, are manipulated by the players to achieve their individual goals. The Politicians want to win elections, the Land Developers want to maximize their assets, and the Residents want to maximize the quality of their environment, as measured by an index.

FIGURE 1

INTERACTION MATRIX

gives to ⟶ ↑	MAYOR	CANDIDATE	LAND DEVELOPERS	LOW INCOME RESIDENT	MIDDLE INCOME RESIDENT
MAYOR			permits	welfare amenity blocks	amenity blocks
CANDIDATE			promises	promises	promises
LAND DEVELOPERS	real estate tax campaign funds	campaign funds		housing building services	housing building services
LOW INCOME RESIDENT	votes campaign funds	votes campaign funds	rent		
MIDDLE INCOME RESIDENT	votes income tax campaign funds	votes campaign funds	rent		

A player whose importance may seem secondary is the other Politician, the Candidate. The Interaction Matrix shows that his influence is small compared with his opponent in office. Actually, he has great influence but his impact, more than any other player, depends solely on his personal abilities as a campaigner and bargainer. He is the least involved with the mechanical operations of the game, yet he must always be aware of them. For this reason he can be said to have the most challenging role.

Hovering over the entire system as described so far are the Crises. When the state of the city has deteriorated beyond certain measureable marks, the city is susceptible to any one of five Crises, depending on the type of danger encountered in the game playing. The Crises are Political, Social, Physical, Economic, and Health. Each Crisis has its own results. The Crises are the great equalizers in the game, for they penalize players unevenly, usually affecting those who have gained most by the existence of Crisis conditions. The Crises provide the fine tuning for the game and are subtle checks and balances on the progress of the game. At the same time they teach certain lessons about the outcome of various modes of behavior. At any rate, if a Crisis occurs, the state of the city is altered through the adjustment of the game's vehicles--money, votes, and Environmental Quality Index.

Fun City operates with a minimum of mechanics and depends mostly on face to face communication and bargaining among players. This is in keeping with the goals and objectives of the game designers. The game's structure, its "insides", become readily discernible to the players after a reasonable amount of time. Much of the playing time is concerned with contract making and that activity is usually the primary concern of the players. Even through most of the mechanical steps during a year of play contracts can be made and bargaining can occur. At all times, mechanics are sacrificed for the pursuit of bargaining.

The game models the complex of bargains and contracts made almost daily in the operation of a large central city. In addition, the results of these interactions and negotiations are traced as they affect both the progress of each of the significant actors in the city and the city itself. The state of the city is compared to some benchmarks to determine in absolute terms whether the city is healthy or in crisis. Hopefully, players learn the one value lesson that is built into the game. The lesson is that in the pursuit of their individual goals, actors in the city must concern themselves with the needs of others if the city is to develop in a healthy and rational way. That lesson is underplayed throughout the game in the hope that the discovery of its truth by each player will have more impact than by lecturing. Indeed, that is the intent of educational gaming itself. Most of the design of this game centers around that one lesson, though other lessons are also there. If the design is to be faulted, it is because of the desire of the designers to demonstrate their basic belief about the city and its operations. Simplifications were made so that players might arrive at the conclusion sooner. The rewards and punishments were structured to enhance the delivery of the object lesson.

The city is an interweaving of many competing, conflicting, or cooperative forces which, when ordered and aligned properly, provide for the improvement and progress of all its elements; that this ordering demands a high degree of sensitivity of each force to the effects of all of the others; and that the proper ordering involves a high degree of cooperation and understanding, rather than the supremacy of any one force. In the extreme, it might be said that that view of the city is the system that is modeled. This model is certainly the planner's view of the city. To the non-planner who plays, the learning of the object lesson in urban planning is much to be desired. To the planner who plans, the difficulty and frustration of the alignment of forces is the significant part of the object lesson. In either case, if the playing of the game induces thought about the subject of the reconciliation of conflict in the city it has succeeded.

"TWO URBAN ELECTION SIMULATIONS AND URBAN ANALYSIS"

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URBAN ELECTION SIMULATION MODELING AND POLITICAL INNOVATION

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In this paper we examine the possibilities of using urban election simulation models such as the Woodbury and DeKalb Mayoralty election simulations as predictive devices and as inducements to innovation in urban politics. These two simulation models have been used heretofore as teaching tools in classes in urban politics, but the writers suggest that the same basic models might be used to study the alternatives possible to political leaders and the probabilities of success of given courses of action. Finally, a course of future development is sketched out.

Potential Uses of Urban Simulation Modeling

The dynamics of urban politics can probably be explored most realistically through the use of simulation techniques.[1] The writers of this paper, both being university professors, have used simulations in their classes as teaching tools, but there is evidence that simulations can also be used as

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[1] Simulation techniques are not new in the social and managerial sciences, having been widely used in business schools for a number of years. Three new simulations designed for use in classes in international business management, for example, are SW-2: A Simulation of International Business in a Political Setting, RLA-1: Regional Latin America Supply and Distribution Simulation, and OIL-1: A Simulation of the International Oil Industry. The first has been played several times, and the last two are under development by Professor Smith. Results of SW-2 simulation runs are reported by Smith and Whithed in Proceedings of the National Gaming Council, Eighth Symposium, June 22-24, 1969; Kansas City, Mo.; Booz Allen Applied Research, Inc.; 1969. Preliminary work along these lines was also reported in Parker, Smith, and Whithed; "Political Simulation; An Introduction, " in H. Ned Seelye, ed.; A Handbook on Latin

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(footnote 1, con't)
America for Teachers; Springfield, Illinois, Office of the Superintendent of Public Instruction; 1968.

Within the political science discipline simulation techniques have previously been applied to international relations and foreign policy situations. The best known of these games is the Inter-Nation Simulation, developed by Professor Harold Guetzkow of Northwestern University and published by Science Research Associates. See Harold Guetzkow and others; Simulation in International Relations: Developments for Research and Teaching; Englewood Cliffs, New Jersey; Prentice-Hall, Inc.; 1963. In the field of American government and politics there are several simulations developed by William Coplin and Leonard Stitelman and published by Science Research Associates. Professor Dale Garvey has developed an American politics game at Kansas State Teachers College, Emporia, Kansas, and a presidential election simulation has been developed by Marvin Weinbaum and Louis Gold and published by Holt, Rinehart and Winston.

Finally, there are several simulations of urban problems, notably The Community Land Use Game (CLUG) by Allan G. Feldt of The Center for Housing and Environmental Studies Division of Urban Studies, Cornell University; the Region and CITY-1 models developed by the Washington Center for Metropolitan Studies (the simulation group there has recently split off to form a firm called Envirometrics, and this group has further developed CITY-1 and also developed CITY-2 and Telecity). Paul H. Ray and Richard D. Duke have moved beyond Metropolis, and report in their developing METRO simulation in a chapter entitled "The Environment of Decision Makers in Urban Gaming Simulations," in William D. Coplin, ed.; Simulation in the Study of Politics; Chicago, Markham Publishing Col; 1968, pp. 149-176. A computer-assisted time-share urban land use simulation model of the CLUG family type is being developed by Whithed at Rensselaer Polytechnic Institute, and A. J. Pennington of the Drexel Institute of Technology in Philadelphia is developing a similar simulation, using time-share computer procedures, called BUILD (see Drexel Institute, Center for the Study of Environment, "Research and Education in Management of Large-Scale Technical Programs, NASA Grant NGL 39-004-020, Second Semi-annual Progress Report," December 31, 1969).

predictive devices and as a means of inducing innovation. In this paper we shall explore the possibilities of using two such simulation models for these latter purposes.

We mean by predictiveness not the outcome of an election --- although one run of our DeKalb simulation came remarkably close to doing so --- but the ability first to delineate the alternative courses of action. Predictiveness, by this definition, is not the ascertainment of finite numbers (such as voting outcomes), but rather, of trends and probabilities.

Inducement to innovation, in our terms, means the ability of simulation models to permit experimentation without irreversible consequences to the roleplayers, such as might be the case if experimentation were attempted in real-life situations. As an example of this ability, consider the desire of a political leader to sponsor a controversial proposal. If he does so in real life, it is at great career risk and without being able, in many cases, to predict who his friends and enemies may be. If, on the other hand, the proposal is sponsored during a simulation exercise, the major elements of support and opposition may be explored under "test tube conditions;" opposition may not be as formidable as anticipated, thus the politician may be encouraged to sponsor the controversial proposal in real life. The ability of simulation modeling to perform the function of "political test tube:" can thus lead, we believe, to the inducement of innovation in governmental action[2].

In this context, then, let us suggest what appear to be the indispensable parameters of a simulation model useful as a "test tube" of urban political

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[2] As Professor Whithed has observed in a recent paper delivered at the Midwest Political Science Association Meeting in Ann Arbor, Michigan, April, 1969:

> "Most simulation models are intended to teach the participants particular skills.... A Major inducement to the utilization of simulation techniques is that the participants can learn from their mistakes without suffering the real-life consequences.... In short, simulation exercises are useful in teaching skills when the consequences of error in the real life context are so costly as effectively to prohibit trial and error learnining."

A similar observation has been made by Colonel William Thane Minor, studies. There is one major question which must be decided initially by the researcher: Is the purpose of the simulation model to explore the internal workings of an urban polity, or is it to study the interactions of the urban polity with an external entity? As an example, take the question of urban renewal in which urban planners have two major considerations: they must satisfy the needs of the internal constituencies --- the groups of urban residents who will be affected personally by urban renewal plans --- and the state and federal governments from which the major portion of the funds must come. A simulation can be designed, of course, which would encompass both internal and external constituencies, and in fact we are considering the development of such a model, but at the present stage of development we have found that more insight may be gained by limiting the field under simulation to one orientation or the other. In part, this conclusion is perhaps due to the fact that the Woodbury-family models have thus far been all-man simulations; that is to say, have been scored by hand, and so must be limited in complexity for logistical reasons. The recent development of a mixed man-computer approach to these simulation models, just now being completed, will of course make the increased complexities of a mixed internal/external constituency model much more feasible.

The elements of a useful simulation model of internal political urban interactions would include a list such as the following: the elected functionaries (mayor, councilmen or aldermen), the appointed governmental entities (such as city manager, planning board, school committee if not separately elected, etc), various political pressure groups (such as the League of Women Voters, Chamber of Commerce, "reform" groups, perhaps Black militant organizations, etc), the communications media, and the electorate. Parameters for the action of the actors in the system would also have to be established, and would be represented in the constraints placed on the activities of the various actors in the simulation (since the Woodbury-family models are characterized by human roleplayers occupying many of these roles, these constraints would' be contained in the scenario documentation provided to the participants), and in the structure of the voting model contained in the simulation.

A simulation of this type can be adapted to the characteristics of a particular urban polity by adding or eliminating roles within each of the basic

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2. con't former Director of the Simulation and Computer Directorate of the Industrial College of the Armed Forces, in his paper entitled "Current and Future Uses of Time-Sharing in Educational Simulation:" Washington, D. C., Industrial College of the Armed Forces: 1968, pp. 4 - 5.

elements as appropriate, and by establishing a voting behavior matrix to fit the city under study. This means that a good deal of care must be taken in selecting the roles to be portrayed; to overlook a role representing an important pressure group might lead to erroneous simulation outcomes. An inventory of the groupings likely to be interested in a given issue is perhaps most effectively made by checking through a directory of local organizations and by getting the assessments of knowledgeable community leaders. The voter matrix can be built through intuitive knowledge of voting patterns in the community augmented by a thorough review of the resultant matrix with persons who are politically knowledgeable in the community, or preferably, the matrix could be built on the basis of survey data.[3]

The DeKalb and Woodbury Simulations

The DeKalb and Woodbury simulations, which we have used in our own classes and classes at several other academic institutions, are simulations of internal urban interactions.[4] As played thus far, they are "man simulations," that is to say, human actors play various roles, and the scoring is performed by human umpires (although we should note that a mixed man-computer version, wherein humans still play the roles, but the "scoring" is done via computer instead of human umpires, is presently almost completely developed). The scenarios for both simulation models are those of a mayoralty campaign. The Woodbury simulation portrays a hypothetical community, is constructed for teaching purposes, and so contains within it a considerable number of urban problems for an instructor to explore with his students. The DeKalb simulation, on the other hand, simulates an actual polity of about 30,000 population, having an additional student population of about 23,000. Consequently,

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[3] The survey data basis is the more desirable, but of course is more costly. We have been developing data processing techniques to handle survey data more expeditiously than the standard methodologies, and expect to implement these techniques with reference to simulation modeling in the future. The schema for this has been worked out, butthis lies beyond the scope of the present paper.

[4] The Woodbury simulation, developed by H. Roberts Coward (Case Western Reserve Univ.), Bradbury Seasholes (Tufts Univ.), Marshall H. Whithed (Rensselaer Polytechnic Institute), and with the assistance of Robert C. Wood (MIT, former Undersecretary of HUD), is to be published by Little Brown and Company. The DeKalb Political Simulation was developed by William Harader (Indiana State Univ. at Terre Haute),

DeKalb has some features unusual to most towns in that it has a large university as a major industry, and the voting populace includes a level of intellectuality and political bias of university faculty members often in opposition to the more conservative bias of the tradesmen and workers. These conservative-radical dichotomies are contrasted with the ethnic and racial politics characteristic of the Woodbury model.

Basic to both simulation models as developed to date is the function of umpire. Both the hypothetical city of Woodbury and the actual town of DeKalb are divided politically into wards (seven in DeKalb, nine or ten in Woodbury depending upon which model is employed). Both models assign an umpire to each ward. In our runs of these simulations, the umpires have been graduate students and professors of political science. Perhaps a more realistic group of umpires could be recruited from knowledgeable townspeople, politicians, and civic groups. The umpires assess the various moves of the roleplaying groups, as reflected in press releases made by the mass media and other activities of the groups. These assessments take the form of moving prospective votes from one candidate to another and/or to or from the politically independent column. The roleplayers generate numerous moves during a simulation run --- some Woodbury games have generated more than + 200 moves to be assessed.

The utilization of human umpires who are particularly knowledgeable about the subject matter to do the scoring and thus control the outcome of the simulation exercise is similar to the use of experts in the field of international relations and diplomacy to judge the direction of an international relations political simulation exercise, the Political Military Exercise or PME.[5]

(Footnote 4 con't)
Clifford N. Smith (Northern Illinois Univ.), and Marshall H. Whithed (Rensselaer Polytechnic Institute).

5. The Political Military Exervise was first developed by Goldhamer et al at RAND Corporation: see H. Goldhamer and H. Speier, "Some Observations on Political Gaming," World Politics, Vol XII, October 1959, pp. 71-83. It has since been used at a number of other universities, especially at MIT. See H. Roberts Coward, The Political Military Exercise as a Teaching Device in Political Science: A Handbook, Final report, Project No. 6-8964, Contract No. OEC-3-7-068964-2199, U. S. Dept. of Health, Education, and Welfare, Office of Education, Bureau of Research, Washington, D. C., 1969.

The DeKalb and Woodbury simulation models vary in that the mayoralty campaign in the DeKalb simulation is officially nonpartisan, whereas the Woodbury model is based on a partisan election. Additionally, thought has been given to including the aldermanic electoral contests in the DeKalb model.

The DeKalb simulation model arose from our experiences with the Woodbury exercise, and from our desire to attempt the development of a Woodbury-type model to analyze the context of non-partisan elections. More importantly, we also wished to explore the research and projection planning possibilities of political simulation techniques based on a Woodbury-type model. This last desire was perhaps understandably enhanced by the fact that one of the developers (Smith) was for a time a mayoralty candidate, and subsequently an aldermanic candidate, in the actual community being simulated, and that the elections in the actual city were to be held within a week after the completion of our simulation run.

Once the decision was made to utilize a Woodbury-type control mechanism (i.e., the ward umpire approach), the development of the simulation model fell into fairly clear-cut, albeit tedious, perspective.

First, the major characteristics of the community to be modeled (such as ethnicity, election-type---in this case, non-partisan mayoralty election---, voting data, issue complexes, history, and so on) had to be identified and then researched.

Secondly, as is the case with all simulations modeling, the developers had to recognize that the simulation model would have to be less than a complete replication of reality in order for it to be manageable and comprehensible to the simulation participants. This implies the necessity of making decisions as to what could be cut from the model, trading off accuracy against usuability and therefore practicality of the resultant model.

Thirdly, a set of voting figures, based on actual past voting data in the community to be simulated, but subsetted to fit the abstracted simulation model had to be developed.

Fourthly, the resultant materials had to be written up and reproduced in quantity. A nitty-gritty detail, and a very tedious one at that, but one which consumed major amounts of time and energy.

The fifth step in our developmental process was to test the resultant model with actual players. This step may be viewed as taking place in two parts: one, ascertaining if the simulation model as a simulation exercise is operational--or "playable." The second part is testing the suitability of the simulation model in replicating the specific community one has hopefully replicated; for this purpose, simulation runs with participants who are knowledgeable with the specific community being simulated are highly desirable.[6] This step is of course necessary for validification of the model and for making any necessary adjustments.[7]

The first run of the DeKalb Simulation had some predictive success. The run was made three days before the actual mayoralty election, which was expected to be very close. The results of the simulation run were within 100 votes of the actual election results, and the mayoral candidate simulated in the game as the winner also won the actual election. Wardwise, the simulation was less accurate in this preliminary run, correctly predicting the winner in three wards out of seven. In a fourth ward, the simulation indicated a very close race, and indeed the result of the actual election was a difference of nine votes out of 995 case.

Given the preliminary nature of the scenario documentation for this simulation run (it was subsequently revised), and the inevitable bugs of a first run, we were quite pleased by the outcome. More to the point, however, was the fact that the simulation exercise enabled us project voting block group reactions in the various wards, and in various combinations, to diverse political strategies to be employed in dealing with the issues of the actual-city campaign then underway.

A Computerized version of Woodbury

The man-umpire approach to the Woodbury-type urban politics simulation model has a number of advantages, particularly for teaching purposes. But on the other hand, the necessity of numerous ward umpires poses a serious logistical problem as the number of wards in a city to be simulated is increased. Also, the logistical coordination burdens in the man-umpire approach more or less effectively preclude much extension of the model to take into account other variables.

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[6] Our preliminary run was made with students at a university in the simulated town. Additionally, we had several politically-involved persons (including two candidates in the actual elections) included in the exercise.

[7] Paul A. Twelker has prepared a brief conceptual discussion of the steps volved in developing and validating a political simulation; see Paul A. Twelker; "Developing Simulation Systems;" in Instructional Simulation Newsletter, Vol. 2, No. 1; February 1969; Teaching Research Division, Oregon State System of Higher Education; Monmouth, Oregon. See also Jack Crawford and Paul A. Twelker; "The Design of Instructional Simulation Systems;" in Paul A. Twelker, editor; Instructional Simulation: A Reserach Development and Dissemination Activity; Monmouth, Oregon; Teaching Research Division; Oregon State System of Higher Education; February 1969.

For these reasons, we have been developing a computer-assisted version and are presently almost completed with the developmental work.[8] In the computerized version of Woodbury, the various groups in each ward are treated as "Voting Block Reaction Groups," Student role-playing teams initiate moves or political actions. The Simulation Director codes the verbally-expressed moves into a preestablished coding scheme in the same manner as open-ended survey question responses are coded into numeric format. When inputed to the computer according to the predetermined coding scheme, these moves are "evaluated" in terms of their specific and commulative effects upon the VBR Groups of each ward. From the data base stored in the computer program, the reaction weightings for the VBR Groups in each ward are generated on a ± 9 scale. Vote distribution shifts of potential voters are reflected in the Gallup Polls provided to the student participants through the remote computer terminal as indicators of the success or failure of their strategies. The vote distribution shifts are totalled for each Gallup Poll, and at the conclusion of the simulation exercise the computer translates the potential vote of the Gallup Poll into "Actual Vote" totals for each ward, according to preestablished formulas representing the differential between potential voters who would be tapped in a survey and actual voter turnout at the polls.

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8. A prototype system was demonstrated at the American Political Science Association Annual Meeting in New York City in September 1969, and again at the Institute of Electrical and Electronics Engineers (IEEE) Systems Science and Cybernetics Group Meeting in Philadelphia in October 1969. Credit for making this developmental work possible must be extended to the General Electric Company, which provided the computer time and facilities for development of the prototype version, Mr. Robert Lund who, as senior programmer, deveoted much "midnight oil" to the project, Mr. Lawrence Birch who served as research assistant, and Mrs. Cherie Campbell who assisted in providing the statistical format for the simulation model. Rensselaer Polytechnic Institute provided a Faculty Research Grant for carrying out some of the necessary work on the development of the computer-assisted model.

The computer printout provided to participants during the simulation exercise thus provides role-playing teams with detailed information regarding the political effects of their specific political moves. Because of the rapid interaction between the role-playing team participants and the simulation model through interactive time-share computer erminals, quick feedback can be provided to the participants. Additionally, in the fully-developed computerized version of the Woodbury-type model, role-playing groups will be able to utilize computer remote terminals to explore the effects on VBR Groups of various alternate strategies before committing their group to a particular strategy.

Flow charts of the simulation system, as well as some sample computer printout, appear at the end of this paper.

A Generalized Urban Electoral Simulation System

Our experiences with the above-mentioned two urban election simulation models suggests the development of a generalized approach, which we call a Generalized Urban Electoral Simulation System (GUESS). As the reader will recall, we have already experimented with the adaption of the basic Woodbury simulation model to explore election questions in an actual city (the DeKalb Political Simulation). Additionally, with the computerized Woodbury Simulation version, we have devised a system which can handle a large number of electoral districts (wards) conveniently; this becomes important when we realize that a large city may have well over fifty wards (a far cry from the seven of DeKalb, or nine or ten, depending upon the model used, of Woodbury).

In the GUESS model, it will be a question of drawing up an appropriate scenario for the participants, plus a representative Voting Block Reaction Groups voting matrix for the GUESS program. Both these tasks can be performed by standard research/consultant group organizations, or by university classes as part of their related course work. Additionally, the voting matrix construction could be developed by political survey techniques.[9]

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9. We have developed techniques whereby appropriate surveys could, with suitable staff direction, be administered by college students as part of their course work, or by campaign worker groups, and translated to machine-readable input automatically and cheaply. This last could then be utilized to construct the VBR matrixes.

The resultant GUESS model, based on a particular urban area, could then be utilized by political leaders to explore the overall electoral consequences of various strategies. As such, the GUESS system could provide an element of predictiveness and an inducement to innovation in political life.

TECHNICAL DATA

THE WOODBURY POLITICAL SIMULATION

COMPUTER ASSISTED VERSION

WOODBURY II PROGRAM

Program description: The program is written in FORTRAN IV for the General Electric Co. Mark Two Time Share Service.

The program is designed to ask questions of the operator. These questions require three categories of response patterns: (T or F for True or False; 2)numeric data, either a quantity or a code number; or 3) a ward name.[1] All calculations are done from the question answers and ward parameters. Each ward file contains all of the parameters necessary to specify group affiliation, group opinion, and voter turnout rate. For examples on I/0, see the pages of specimen computer printout immediately following.

After the operator has accessed the file containing the execution form of the program, he should type 'RUN' followed by a return. The program will respond with the heading and the first question, 'YOU WANT FINAL ELECTION RESULT (T OR F)?'. A response on the part of the operator of 'T' will cause the program to print out the resultant data if an election were held at that point (point # 1, see below). The program will then print "WARD? The operator should type the name of the ward for which he desires election results. The program will retrieve that ward file, compute the turnout rates for each party and the split of the Independents (undecided voters), and print the resultant figures followed by the query, 'END OF FINAL ELECTION RESULTS (T OR F)?'. If the operator has already specified all of the wards he is interested in, he should respond by typing 'T'. The program will then list the sum for the indicated wards and terminate. However, if the operator has more wards which he wishes to examine, he should type 'F' to cause the program to recycle to Point # 1 above and continue. For an example of this routine, see page 16.

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[1] Each ward is given an alphabetic name instead of a number as in the man-controlled version of the Woodbury Political Simulation.

Had the operator indicated that he did not desire the election results (by typien 'F' to the computer query at that point), the program would then type 'YOU WANT AREA POLL RESULTS (T OR F)?'. This question, when answered in the affirmative ('T') causes the program to sum the voters by Votin g Block Reaction Group as the operator specifies wards. If the operator does not wish this calculation, he should respond 'F'. In either case, the program then queries 'WARD?', and the operator should respond with the name of the ward he wishes to poll (example - - 'SILK').

The program then queries, 'YOU WANT TO POLL THE VOTER BASE (T OR F)?'. A response of 'T' would allow the operator to poll the reactions of selected Voting Block Reaction Groups to selected coded actions or moves made by role-playing groups on a ward-by-ward basis. After a response of 'T' the program would respond 'NUMBER OF VOTING BLOCK REACTION GROUPS MAXIMUM IS SIX?'.[1] The appropriate respons here is a number greater than 0 and less or equal to 6.[1] The program then prints, 'VOTING BLOCK REACTION GROUPS BEING POLLED (X)?', where X is the number previously specified. The operator should respond with the requested number of V. B. R. group code numbers separated by commas, blank spaces, or carriage returns. The program will check the values and, if they are allowable, ask 'YOU WANT DESCRIPTION OF GROUPS (T OR F)?'. A 'T' would cause the program to define each of the specified group code numbers (that is to say, the program contains its own dictionary listing). If these definitions are not desired, the operator should type 'F'. In either case, the program will produce the poll listing for the specified ward and ask, 'END OF POLL (T OR F)?'.

If the operator types 'F', the program will ask for the next 'WARD?'. Here the operator should type in the name of the next desired ward. A response of 'T' to the 'END OF POLL' query terminated the routine.

The final segment of the program routine, which is reached by responding negatively ('F') to each preceding question, is the actual shifting of potential voters in each of Woodbury's wards on the basis of the imput of actions (moves submitted by role-playing groups) expressed in number-coded form. An action affect matrix for all possible/allowable actions for each ward is established in the program data base. As a particular action code "line" of the matrix is specified by the operator, the program causes a table look-up of the voter weights for that code for each ward, and adjusts/updates the vote totals in each ward accordingly. It is through the utilization of this program subroutine that the voter indentification data base is updated to roccespond with the moves made by simulation role-playing groups.

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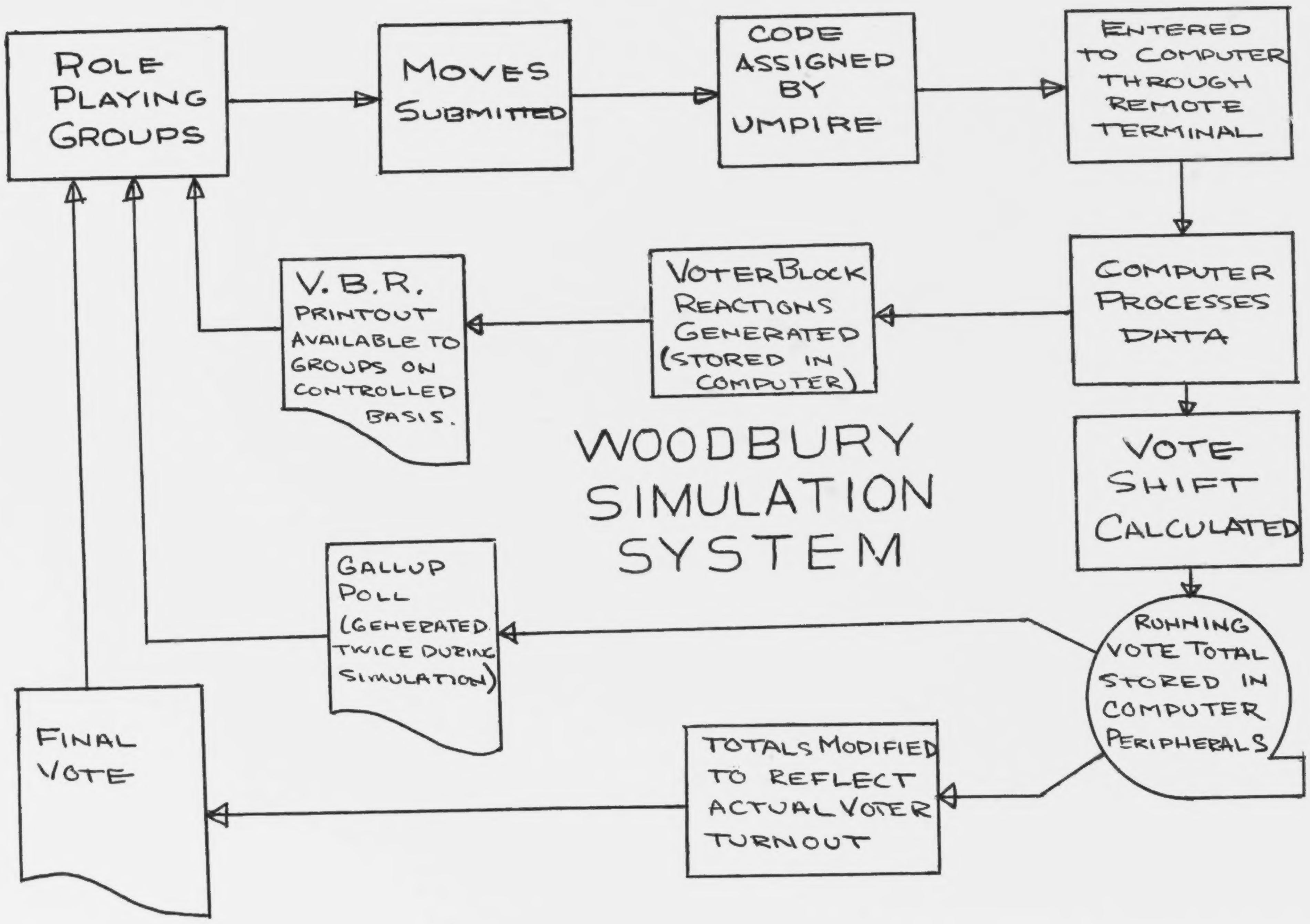
[1] Or fifteen.

This segment of the program also contains a dictionary of action codes, which is accessed by typing 'T' in response to the query, 'YOU WANT DESCRIPTION OF ACTIONS (T OR F)?'.

The operator is required to indicate whether the action in question is oriented towards affecting the Democrats or Republicans (this is apparent from the action code description -- see specimen printout) in response to the query 'PARTY UNDER QUESTION IS DEMOCRAT (T OR F)?'. If the party in question is Republican, the operator types 'F'.

Each ward must be specified separately, and is so done by answering 'F' to the query 'END OF VOTE SHIFTING (T OR F)?', until all affected wards have been analyzed.

ROLE PLAYING GROUPS
MOVES SUBMITTED
CODE ASSIGNED BY UMPIRE
ENTERED TO COMPUTER THROUGH REMOTE TERMINAL
COMPUTER PROCESSES DATA
VOTERBLOCK REACTIONS GENERATED (STORED IN COMPUTER)
V.B.R. PRINTOUT AVAILABLE TO GROUPS ON CONTROLLED BASIS.
WOODBURY SIMULATION SYSTEM
VOTE SHIFT CALCULATED
RUNNING VOTE TOTAL STORED IN COMPUTER PERIPHERALS
GALLUP POLL (GENERATED TWICE DURING SIMULATION)
TOTALS MODIFIED TO REFLECT ACTUAL VOTER TURNOUT
FINAL VOTE

```
     WØØDBURY POLITICAL SIMULATIØN

YØU WANT FINAL ELECTIØN RESULTS (T ØR F)?T

WARD?SLUM

DEM'S        15600   REP'S        2800   IND'S        14600
END ØF FINAL ELECTIØN RESULTS (T ØR F)?T

FINAL ELECTIØN RESULT
DEMØCRATS               15600
REPUBLICANS              2800
DID NØT VØTE            14600

PRØGRAM STØP AT 8300

USED     .35 UNITS
```

```
     W 0 0 D B U R Y   P 0 L I T I C A L   S I M U L A T I 0 N

Y0U WANT FINAL ELECTI0N RESULTS (T 0R F)?F

Y 0U WANT AREA  P0LL RESULTS (T 0R F)?T

W ARD?SILK

Y0U WANT T0 P0LL THE V0TER BASE(T 0R F)?T

NUMBER 0F V0TING BL0CK REACTI0N GR0UPS MAXIUM IS SIX?6

V0TING BL0CK REACTI0N GR0UPS BEING P0LLED (          6)?1 2 3 4 5 6

Y0U WANT DESCRIPTI0N 0F GR0UPS   (T 0R F)?T

Groups recieved as:
 1) IRISH
 2) ITALIAN
 3) NEGR0
 4) JEWISH (ETHNIC)
 5) YANKEE
 6) GERMAN



                   W00DBURY P0LITICAL SIMULATI0N
                         V0TER P0LL #        27

 W ARD:  SILK

 V.B.R. GR0UPS        DEM0CRATS     INDEPENDENTS     REPUBLICANS
       1                  0               0               0
       2                  0               0               0
       3                  0               0               0
       4                 50              30             250
       5               4410            2736           22554
       6                446             272            2252

 T0TAL                 4906            3038           25056


 END 0F P0LL (T 0R F)?F

 W ARD?SLUM
```

```
                         WOODBURY POLITICAL SIMULATION
     VOTER POLL #              27

WARD:  SLUM

V.B.R. GROUPS            DEMOCRATS      INDEPENDENTS      REPUBLICANS
         1                 1149              222               279
         2                 2299              447               554
         3                15103             6542              6405
         4                    0                0                 0
         5                    0                0                 0
         6                    0                0                 0

TOTAL                     18551             7211              7238


END OF POLL (T OR F)?F

WARD?EAST


                         WOODBURY POLITICAL SIMULATION
     VOTER POLL #              27

WARD:  EAST

V.B.R. GROUPS            DEMOCRATS      INDEPENDENTS      REPUBLICANS
         1                24856             2176              4318
         2                    0                0                 0
         3                    0                0                 0
         4                    0                0                 0
         5                    0                0                 0
         6                 1372               34               244

TOTAL                     26228             2210              4562


END OF POLL (T OR F)?T


 AREA POLL RESULTS
DEM'S        49685   IND'S        12459   REP'S          36856


PROGRAM STOP AT 28000

USED    2.45 UNITS
```

```
     W Ø Ø D B U R Y   P Ø L I T I C A L   S I M U L A T I Ø N

YØU WANT FINAL ELECTIØN RESULTS (T ØR F)?F

YØU WANT AREA  PØLL RESULTS (T ØR F)?F

WARD?SILK

YØU WANT TØ PØLL THE VØTER BASE(T ØR F)?F

YØU       ØPINIØN PØLL (T ØR F)?T

NUMBER ØF VØTING BLØCK REACTIØN GRØUPS MAXIUM IS FIFTEEN?8

VØTING BLØCK REACTIØN GRØUPS PØLLED (            8)?1 2 3 4 5 6 10 11

YØU WANT DESCRIPTIØN ØF GRØUPS   (T ØR F)?T

 GRØUPS   RECIEVED AS :
  1) IRISH
  2) ITALIAN
  3) NEGRØ
  4) JEWISH (ETHNIC)
  5) YANKEE
  6) GERMAN
 10) PØØR EDUCATIØN
 11) GØØD EDUCATIØN (CØLLEGE)
NUMBER ØF ACTIØNS BEING PØLLED MAXIUM=60?4

ACTIØNS BEING PØLLED (            4)?1 3 5 19

YØU WANT DESCRIPTIØN ØF ACTIØNS  (T ØR F)?T

 ACTIØNS  RECIEVED AS :
  1) BLACK PANTHERS SUPPØRT DEMØCRAT CANDIATE
  3) DEMØCRATS RUN A VØTE DRIVE
  5) DEM. CANDIATE PRØPØSES FREEWAY THRØUGH EAST & WEST WARDS
CHANGES (T ØR F)?F
```

```
                           WØØDBURY PØLITICAL SIMULATIØN
                           REACTIØN PØLL #         6

WARD: SILK

ACTIØN                 VØTING BLØCK REACTIØN GRØUPS
                  1    2    3    4    5    6   10   11

 1                0    0    0    0    0    0    0    0
 3                0    0    0    0    0    0    0    0
 5                0    0    0    0    0    0    0    0
19                0    0    0    0    1    0    0    1

REACTIØN CØDED +/- DEPENDING ØN PARTY IT CØNCERNS.


END ØF REACTIØN PØLLING (T ØR F)?F

WARD?SLUM

                           WØØDBURY PØLITICAL SIMULATIØN
                           REACTIØN PØLL #         6

WARD: SLUM

ACTIØN                 VØTING BLØCK REACTIØN GRØUPS
                  1    2    3    4    5    6   10   11

 1               -5   -5    6    0    0    0    5   -1
 3                2    2    5    0    0    0    4    1
 5               -6   -6   -8    0    0    0   -8   -6
19                0    0    8    0    0    0    8    4

REACTIØN CØDED +/- DEPENDING ØN PARTY IT CØNCERNS.


END ØF REACTIØN PØLLING (T ØR F)?F

WARD?EAST


                           WØØDBURY PØLITICAL SIMULATIØN
                           REACTIØN PØLL #         6

WARD: EAST

ACTIØN                 VØTING BLØCK REACTIØN GRØUPS
                  1    2    3    4    5    6   10   11

 1                0    0    0    0    0   -1   -5   -1
 3                3    0    0    0    0    2    3    0
 5                2    0    0    0    0    2    2    2
19               -6    0    0    0    0   -4   -6   -2

REACTIØN CØDED +/- DEPENDING ØN PARTY IT CØNCERNS.
```

```
RUN

W00DIIG0     10:55      09/03/69



     W 0 0 D B U R Y   P 0 L I T I C A L   S I M U L A T I 0 N

Y0U WANT FINAL ELECTI0N RESULTS (T 0R F)?F

Y0U WANT AREA  P0LL RESULTS (T 0R F)?T

WARD?EAST

Y0U WANT T0 P0LL THE V0TER BASE(T 0R F)?F

Y0U WANT 0PINI0N P0LL (T 0R F)?F

Y0U WANT V0TE SHIFT (T 0R F)?T

PARTY UNDER QUESTI0N IS DEM0CRAT (T 0R F)?F

NUMBER 0F ACTI0NS BEING P0LLED MAXIUM IS SIXTY?6

ACTI0NS BEING P0LLED (          6)?2,8,14,16,18,20

Y0U WANT DESCRIPTI0N 0F ACTI0NS  (T 0R F)?T

  ACTI0NS  RECIEVED AS :
  2) BLACK PANTHERS SUPP0RT REPUBLICIAN CANDIATE
  8) W00DBURY TIMES AND TELEGRAPH SUPP0RTS REPUBLICIAN CANDIATE
 14) INCUMBENT MAY0R SUPP0RTS REPUBLICIAN CANDIATE
 16) REPUBLICIAN CANDIATE PR0P0SES PUBLIC TRANSIT FARE INCREASE
 18) REPUBLICAN CANDIATE SUPP0RTS URBAN RENEWAL IN THE SLUM WARD
 20) N.A.A.C.P. SUPP0RTS REPUBLICIAN CANDIATE


CHANGES (T 0R F)?F
```

```
                    WØØDBURY PØLITICAL SIMULATIØN
                     VØTE SHIFT #          6

WARD: EAST

ACTIØN         DEMØCRATS        INDEPENDENTS        REPUBLICANS
 2                   0               228               -227
 8                -299               298                  2
14                -981               964                 18
16                  42                88               -129
18                   0                 0                  0
20                  56               102               -157

NEW TØTAL        26818              1680               4507


END ØF VØTE SHIFTING (T ØR F)?F

WARD?SILK



                    WØØDBURY PØLITICAL SIMULATIØN
                     VØTE SHIFT #          6


WARD: SILK

ACTIØN         DEMØCRATS        INDEPENDENTS        REPUBLICANS
 2                   9                69                -77
 8                   0                 0                  0
14                -138                54                 85
16                 -88                32                 57
18                -138                48                 91
20                 -45                26                 20

NEW TØTAL         4600              3229              25176


END ØF VØTE SHIFTING (T ØR F)?F
```

```
W ARD?SLUM
```

```
                    WOODBURY POLITICAL SIMULATION
                      VOTE SHIFT #          6

WARD: SLUM

ACTION         DEMOCRATS        INDEPENDENTS       REPUBLICANS
 2                -863               873               -7
 8                   0                 0                0
14                -229               221                9
16                  27               139             -165
18                  97               441             -537
20               -1212              1123               90

NEW TOTAL        23820              2797             6390


END OF VOTE SHIFTING (T OR F)?T


 AREA POLL RESULTS
DEM'S        55238   IND'S         7706    REP'S        36073


PROGRAM STOP AT 28000

USED    2.74 UNITS
```

"URBAN GAME DESIGN"

Parris Glendening
Department of Government and Politics
University of Maryland

URBAN GAME DESIGN

Parris Glendening
Assistant Professor
Department of Government and Politics
University of Maryland

abstract

This paper describes a course instituted in the Honors Program at the University of Maryland.

In the fall of 1969, the University of Maryland offered an interdisciplinary course in urban problems in the Department of General Education. Students in the course were involved in a number of manual and computer-assisted games dealing with different aspects of urban affairs. A number of honor students felt there was a need to design new games relevant to urban problems.

The author and 15 honor students have been, over the course of the spring term, attempting to study the many facets of game design, hoping eventually to construct a number of manual models.

The paper will describe the problems involved in conducting such a course.

"PROBLEMS IN VALIDATION OF FUTURE CONCEPTS"

Norman Farrell
Combat Developments Command

PROBLEMS IN VALIDATION OF FUTURE CONCEPTS

BY

COL. NORMAN FARRELL (USA RTD.)
Consultant, Institute of Land Combat

Gaming of Very Long Range Land Combat Systems (VLRLCS) cannot be validated in the same sense that comparison with the known events of historical engagements may be used to validate a war gaiming system. In fact, it is impossible to validate or even feel highly confident of the similarity to real life with which a game represents a VLRLCS.

Representation of VLR materiel systems can be handled in the same way it is handled for near or mid-term systems -- by assuming that specified performance characteristics will be attained, by identifying critical assumptions through sensitivity analyses, and by parameterizing critical values.

Representation of VLR concepts, however, is much more awkward to handle. Concepts seldom have absolute values, as materiel systems do. More importantly, they are sharply affected by the enemy tactic chosen, which is totally unknown. In near term gaming we use experience data considered valid or relevant as the basis for establishing gaming rules for use during play. In VLR gaming, when the concepts are likely to be new and different, no data from the past seems relevant. We must then break the combat operations down to the lowest or simplest level and by repeated human judgments attempt to synthesize experience. We then aggregate this synthetic experience at increasingly higher or more complex levels of combat. To compensate for the totally unknown enemy tactics and materiel, wisdom dictates that we parameterize each within the limits considered feasible for the enemy.

The final uncertainty to be applied in gaming VLRLCS comes from the effort necessary to achieve the uncertain effects we have derived. Resource availability, costs and requirements are all uncertain for even the mid-term future.

"VALIDATION OF COMBAT MODELS AGAINST HISTORICAL DATA"

William Fain, Janice Fain
Consolidated Analysis Centers, Inc.,
Leon Feldman, Susan Simon
Center for Naval Analyses

VALIDATION OF COMBAT MODELS AGAINST HISTORICAL DATA

by

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and

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Introduction

The topic of this paper is model validation through the use of historical data-- and I should point out that I shall be talking entirely about the validation of warfare models.

I have divided this topic into two parts. First, I will say a few words about model validation in general. In this part I shall cover some of the difficulties in dealing with historical data, and I will touch on some of the previous validation efforts.

In the second part I shall describe some of our recent work at CNA on an attempt at the validation of our Tactical Warfare Simulation Program using data from the 1950-53 Korean War.

Part I - General Remarks About Validation

The validation of models is probably one of the most controversial subjects in Military Operations Research today. About the only aspect that analysts will agree on is that it ought to be done. Beyond that there is considerable disagreement even about what model validation is. Part of the reason for this is that there is disagreement about what a model is. There is not time now for a discussion of the different entities that have been referred to as models. For this purpose, the following definition proposed by E. S. Quade of the

RAND Corporation will serve.

> "A model is a simplified representation of the real world which abstracts the features of the situation relevant to the questions being studied."

Now what do we mean by the validity of such a model?

I shall say that the model is valid if it can be shown that two conditions hold:

- There is a one-to-one correspondence between elements in the model and significant elements in the real world, and
- The element interactions are specified correctly.

Now by what process can we determine if these conditions are satisfied?

The first is easier. One can simply compare a list of model elements with a list of real world elements. The key word here is significant. Which elements are significant depend on the question that the model is constructed to answer. Whether or not the analyst has asked the correct questions or defined his real world system correctly are, as I said, of paramount importance to the study; but they do not determine the validity of the model.

Now, how can one tell from historical data whether or not the second condition holds--that is, whether or not the element interactions are specified correctly?

Model elements are defined by characteristics, or attributes, which are quantitative variables that describe some facet of their nature. For example, the characteristics of a military combat unit may be the number of personnel or weapons in the unit, or some such measure of the unit's combat strength, and its location, or position, area covered, etc.

A model can be regarded as a device for taking the values of the elements at some initial state (or time) and producing the values for these same characteristics, at some other state (or period of time).

Model validation in the sense I am discussing will mean giving the historically correct values to the characteristics at the beginning state (or specified time), turning the model on to operate according to its logic, and tabulating the characteristics of the model elements at the end of the period. If the model output values and the historical values "match," then the processes inside the model are said to match the processes in the real world and the model is valid. There are, of course, some very serious and difficult statistical problems buried in this. Each historical sequence can perhaps be considered a poorly selected sample out of a population governed by a very complex distribution. Thus, a match or mis-match may be due to the variance in the "true function" as well as to an incorrect abstraction of the physical process (i.e., a bad model).

And there are other questions which arise. We feel, for example, that the validity of a model is better established if it can allow the characteristics of many elements to be matched over a longer time period than one that matches historical data over a shorter period for fewer elements. But how many elements the model should treat, for how long a time period, and how well established a model's validity must be, we cannot answer.

Until it is possible to establish some quantitative standards of model validation, the use of historical data may well continue to provide negative information. It will not allow us to say that the model is validated, but that none of our work indicates that this model is invalid.

In spite of these difficulties, the demonstration that a model can match, at some level, historical situations remains one of the more convincing evidences that the model bears a valid resemblance to the real world.

Let me say a few words about the difficulties involved in using historical warfare data. Since warfare is not designed to generate data for analysts, many factors which are of great interest to the analyst and military historian are mostly unrecorded. Getting really good data is an probably always will be virtually hopeless. Thus, a list of all the difficulties could be quite long. The main problems are:

1. There is a very limited quantity of data
2. It is of very poor quality: there are large gaps and much "noise" in the system
3. Apparently, much of the data is biased, e.g., estimates of enemy casualties
4. Many variables are involved--some of which are not identified, and the data doesn't begin to be available in a manner that would reflect good experimental design criteria.

There is, in addition, one difficulty I have not seen discussed elsewhere--namely that in the historical data, the following two factors are not separated: what the forces can do; what the forces actually do.

In models used in force level/force mix studies, it is the former factor that we are trying to evaluate, i.e., what the capabilities of the forces are.

Using historical records to validate these models means that, in effect, some level of random noise has been added to the real world data we are trying to use in our validation efforts.

Let me give an example of what I mean--there were static periods during the Korean War when the two forces sat facing each other. A combat model might predict an engagement, with both sides suffering casualties until one of the other is annihilated, or withdrawn, or reinforced, or whatever his resources allowed. The fact that combat did not take place was a result of decisions taken outside the battle area.

At the conference on model verification which was held in October 1968 at CNA, Dr. Arnold Moore, Director of NAVWAG, of CNA expressed this same notion by pointing out that warfare is not allowed to proceed on its own, according to the physical laws governing the weapons possessed by the combat forces. As he said, "warfare is much of a managed process. Attrition, for example, is managed very actively. . . somehow you have to understand the way it has been managed to understand what the data tells you as you are trying to confirm or verify the model."

Despite all the difficulties, there may be some offsetting factors. At a sufficiently aggregated level, some of the physics of warfare may give macroscopic properties that are almost deterministic in nature. For example, although prediction of whether or not an individual will become a casualty may be impossible, the total casualties produced by large numbers of men in close combat may be essentially determined by a small number of factors. However, simple general models of warfare tend to be elusive. On the one hand, Joe Engel was able to obtain good agreement between the Iwo Jima battle data and a simple Lanchester model relating strength of units and casualties (and I will discuss this a bit more in a moment, since it is sort of a classical or classroom example of model verification). On the other hand, Willard found from analyzing gross casualty figures from 1500 historical battles that there was little hope for a simple model relating casualties to total strength of units. I believe this can be explained to some extent by the fact that the Iwo Jima battle satisfied the basic Lanchester assumptions, while most of the Willard battles probably did not.

The information available to Dr. Engel were daily U. S. losses and force strengths and the initial Japanese strength and the length of the battle. The "model" considered by Dr. Engel was rather simple: It consisted of one enemy unit and one U. S. unit. The two units engaged in combat until the enemy unit was annihilated.

I am sure you are all familiar with Dr. Engel's original paper published in the ORSA journal in 1954. You may be interested in Dr. Engel's own evaluation of that work some 14 years later at the CNA conference.

He says,

> "I was able to show in that particular paper that the losses that were experienced on the United States side in the invasion of Iwo Jima were consistent with a particular formulation of a pair of differential equations, and that this consistency was fairly good to the extent that it was necessary to use only two parameters with these particular equations. . ."

Figure 1 shows the agreement he obtained between theoretical and actual force levels. Although Dr. Engel found that the agreement between the U. S. losses predicted from the equations and the actual losses was very good, he was cautious about drawing conclusions from this agreement. He goes on to say,

> "So by the choice of two numbers it was possible to demonstrate that the hypothesis that a certain pair of equations fitted this particular situation was not invalidated by the data that was present."

As to the strong conclusion that the equations fitted this particular battle, he had this to say:

> "Even this kind of limited conclusion was not fully justified by the data because the situation was a two-sided combat situation, and we only had good data pertaining to one side. We didn't know what the daily casualties on the Japanese side of the battle were. We merely knew. . . that they had a certain amount of troops at the beginning of the battle and that they were annihilated by the end of the battle."

As Dr. Engel went on to say, "it was quite possible that other equations might have reproduced the United States data just as well as the equations used, and also fit the Japanese data as well, if it had been available."

Since Dr. Engel's work, there have been a few further efforts to validate the Lanchester equations. For example, at CNA J. J. Busse of MCOAG has applied simple Lanchester equations to the Inchon-Seoul Landing operation during the Korean War. And Herb Weiss has done a beautiful piece of work with civil war data

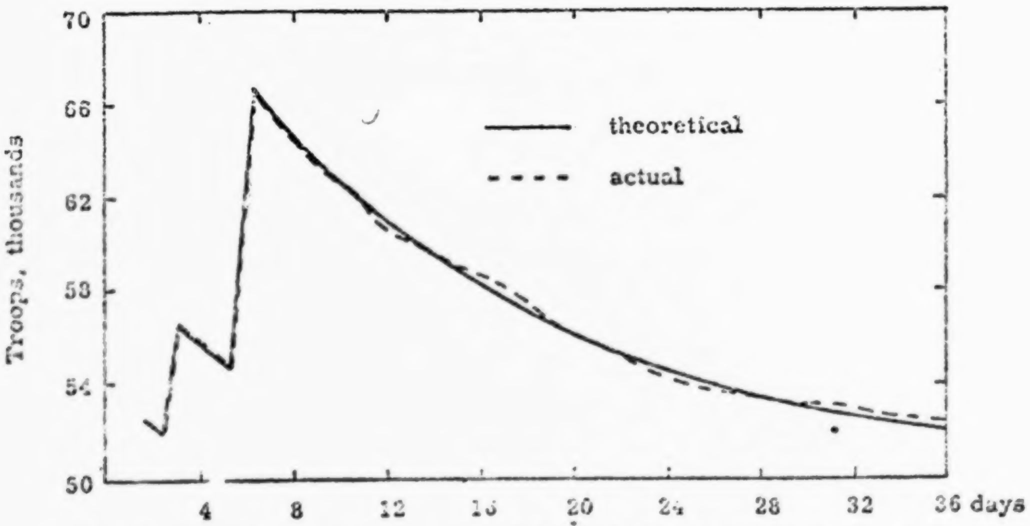

Fig. 3. Theoretical and actual casualties during the capture of Iwo Jima. Reprinted from *Opns. Res.* 2, 169 (1954).

Figure 1

trying to find simple relationships. However, there has been very little work done on the validation of the larger more complex combat simulations through the use of historical data.

Outstanding in this sparsely populated area is the work on the Fast-Val model at RAND. This is a very detailed model of small unit (roughly company-sized) operations. Using data collected in Vietnam they have simulated operations around KheSanh, getting, I understand, remarkable agreement between casualties predicted by the model and the actual casualties recorded there.

By and large, however, model builders have little to be proud of in this area, and it is to be hoped that conferences like this one will result in much greater emphasis being placed on this subject.

In all fairness to the analysts, it should be pointed out that one of the reasons that so little has been done with historical data is that so little quantitative data of the kind and quality needed for this type of work has been available. There are massive collections of information from both World War II and the Korean War. Suprisingly, however, very little quantitative examination has been made.

Part II - Test of a Simulation Model with Korean War Data

Now I want to describe some of our recent work at the Center for Naval Analyses in relating models to real warfare experience. This model verification effort was part of a much larger project, SLAT, A Study of Land/Air Trade-offs. We called SLAT a pilot study. In it we were attempting to carry out two tasks:

> First, to conduct a demonstration analysis of a problem involving trade-offs between tactical air and ground forces in a real world situation, using already-developed methodology, and
>
> Second, to undertake, independent of, but in parallel with the demonstration analysis, a test against historical experience of the model used in the study.

The primary model that we used was our tactical warfare simulation program (TWSP). This model puts together the major features of tactical warfare--such features as the attack plans of the offensive forces and hold/retreat plans for the defenses. The model incorporates the effect of terrain on both movement and combat. TWSP is essentially a set of building blocks that will allow the military planner to create his concept of the action, and then to determine the results of that action.

The model is Lanchester in nature; that is, the rate at which a unit (or group of units) loses strength during close combat is proportional to the strength of its opposition. Losses to supporting fire are proportional to both the strength of the firing units and also to the strength of the target unit.

The model output includes the offensive and defensive unit strengths and positions as functions of time.

The first step in using historical data in model validation is collecting the data. For reasons that I will not go into here, we chose the 1950-53 Korean War for our study.

There are a number of well-written narrative accounts of this war. However, these secondary sources, while providing general background information about the action, seldom contained the numerical values needed for quantitative work. As far as possible, we used contemporary records compiled in the field. The primary sources of data were the Corps command reports and war diaries of the U. S. Eighth Army in Korea.

From daily Corps and Division records we obtained information on the following items for both the friendly and enemy forces:

amount of close air support
amount of heavy artillery
amount of light artillery
friendly strength
enemy strength
friendly casualties
enemy casualties
ground gained

As I said earlier, historical data is usually or poor quality. The times of greatest activity are of the most interest to analysts; however, those are the times when the least data is recorded. In times of light activity, much more detailed and quantitative data is found in the records.

We were, however, able to find sufficient detailed information on three battles to use as tests of the model. These were: the Heartbreak Ridge battle, and Soyang River Campaign, and the Inchon-Seoul Landing.

In simulating the historical battles with the Tactical Warfare Simulation Program,

> The tactics and maneuvers were developed from the actual overlays and detailed after-action reports found in the contemporary historical documents.

Terrain features were taken from the terrain shown on the overlays and campaign maps.

Fire support was assigned as indicated in the Division records.

The killing rates of the units were calculated in two ways:

1. An empirical method in which the kill rates were calculated from this historical data itself. Using the known engagement times, unit strengths and casualties, inferred killing rates were derived and averaged over all units of a given type. This method forced a match between the casualties predicted by the model results and the historical data at the beginning and end. The real test of the model, then, lies in how well the two match during the course of the battle.

2. The other method that was used was a theoretical method calculating attrition from the indices of fire power potential. Stated qualitatively the IFP is the ability of a unit to inflict casualties. It is based on the weapon composition of the military units and is translated into attrition rates when the posture and composition of the enemy is taken into account.

Heartbreak Ridge was a rather simple battle, and we used it as the first test of our methodology. The order of battle of the enemy and friendly forces are shown in Figure 2. The friendly forces were elements of the Second U. S. Division, and included three infantry battalions, five field artillery battalions, a tank company and tactical air support from U. S. Air Force Tactical Air. The enemy forces were elements of the Fifth North Korean Corps, and included three infantry regiments and two artillery regiments. We had data for five days of combat, and Figures 3 and 4 show the friendly and enemy cumulative casualties for those five days. The solid dark line shows the historical casualties. The dashed line indicates the casualties predicted by our simulation, using what I described as the empirical method (where we calculate the coefficients directly out of the strength and casualty information for the various units), and the dotted line is the casualties calculated in the simulation, but using the theoretical approach where we calculated attrition coefficients from the best estimates of weapon composition of the units that were involved. As I said before, the empirical method tends to force the end points to fit because we have calculated directly out of the historical information, while the IFP (theoretical) method does not necessarily force the end points to fit. We were surprised at how well the IFP method fit on the friendly casualties; as you can see, the enemy casualty simulation did not fit quite as well.

ORDER OF BATTLE – HEARTBREAK RIDGE

BLUE (2ND U.S. DIVISION)
  3 INFANTRY BATTALIONS
  5 FIELD ARTILLERY BATTALIONS INCLUDING
  DIV. AND CORPS ARTILLERY
  1 TANK COMPANY
  USAF TACTICAL AIR

RED (Vth NORTH KOREAN CORPS)
  3 INFANTRY REGIMENTS
  1 ARTILLERY REGIMENT

Figure 2

HEARTBREAK RIDGE BATTLE
FRIENDLY CUMULATIVE CASUALTIES

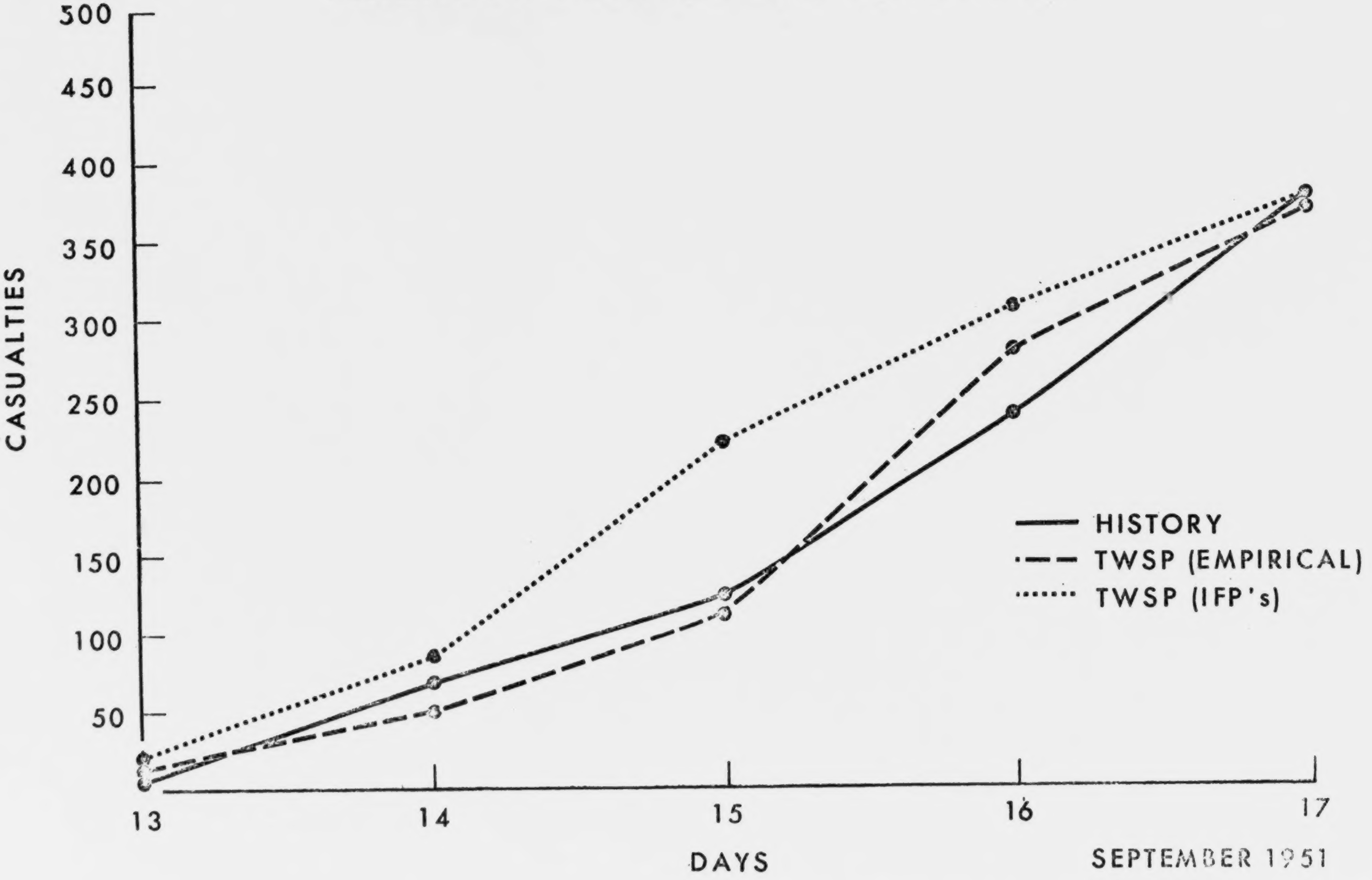

Figure 3

HEARTBREAK RIDGE BATTLE
ENEMY CUMULATIVE CASUALTIES

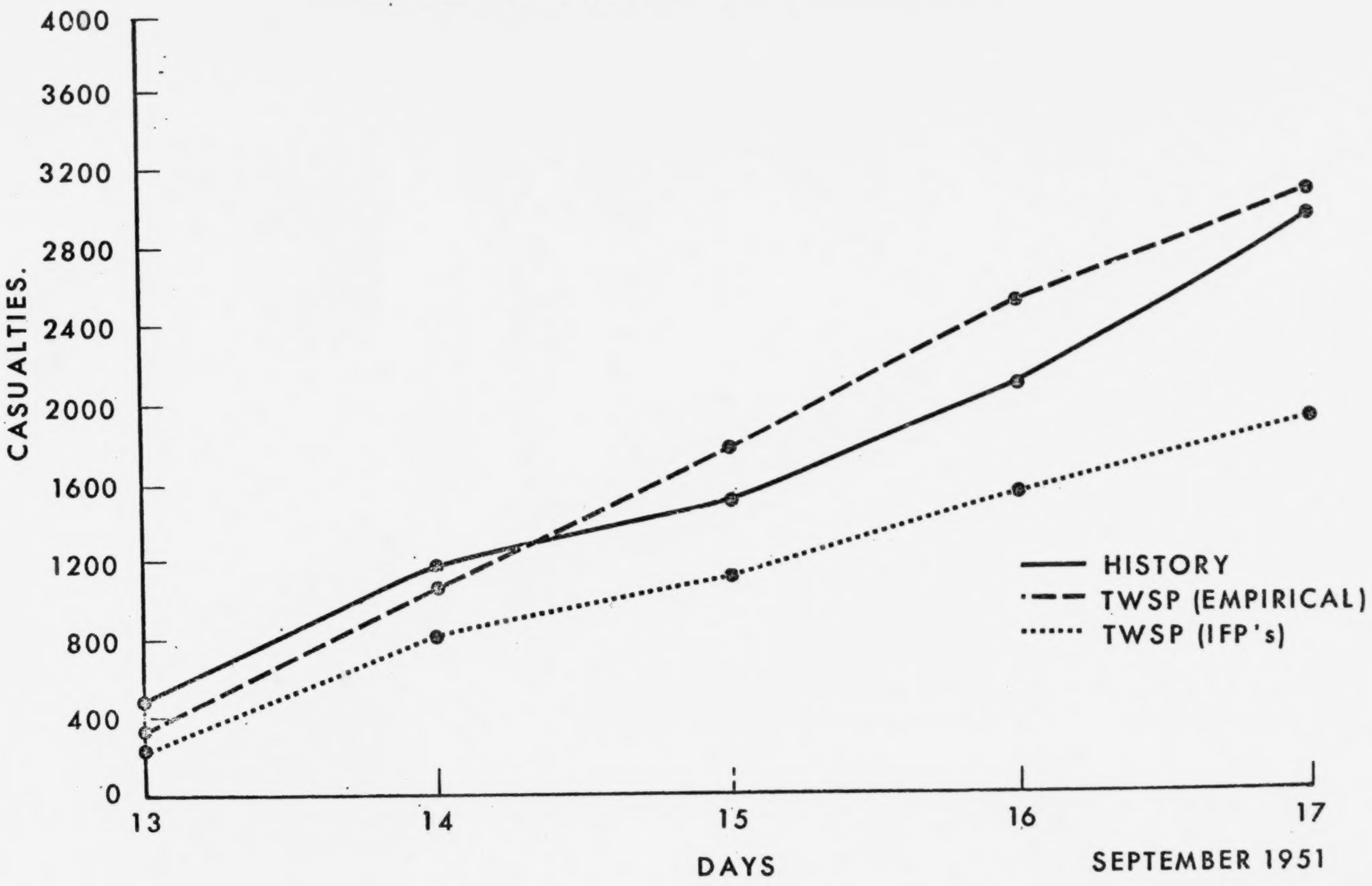

Figure 4

We also plotted the same information for a much more complicated battle, The Inchon-Seoul Landing, where we actually had our best data. The forces involved were these: The North Koreans had 77 units that we know about, platoon and battalion in size. There were ten identifiable unit types and some 83 local engagements. These engagements involved more than one unit and were from 10 minutes to 12 hours in duration. The U. S. Marine Corps had 11 battalion-size units in the operation.

We used five unit types with several supporting units. The type of results that we obtained are shown in Figures 5 and 6. These show the friendly and enemy cumulative casualties for the 18 days of the landing that we had good detailed information on. Again, the solid line is the historical casualties. In Figure 5, the irregularly dashed line (and it follows very closely to the historical casualties) is the empirically calculated casualties and the other dashed line is the one where we based our attrition rates on our best estimates of the weapon composition of the forces involved. Figure 6 shows the enemy cumulative casualties for the same period of time. The dots on this figure are empirical results. This time they were so close that you could not distinguish between the empirical and historical results. The dashed line is the one from the IFP results.

Let me review what we have done relative to our definition of model validity, which is that there is a one-to-one correspondence between elements in the model and significant elements in the real world and that the element interactions in the model are specified correctly. Relative to the first condition we have shown that there does exist for each model element a correspondence with the real world. The second condition is quite a bit more difficult, i. e., to show that the element interactions in the model are specified correctly.

The validity and applicability of the TWSP model as an analytical tool for characterizing warfare interaction depends on several basic assumptions:

1. That military units can be characterized by their ability to cause casualties

2. That the casualty production of a military unit is of the mathematical form of the Lanchester equations used in the model

3. That the kill rates of the units are related to the weapon composition and ammunition expenditure of the firing unit and the posture of the target unit

4. That the tactical behavior of the units can be represented by the TWSP tactical options available to the planner.

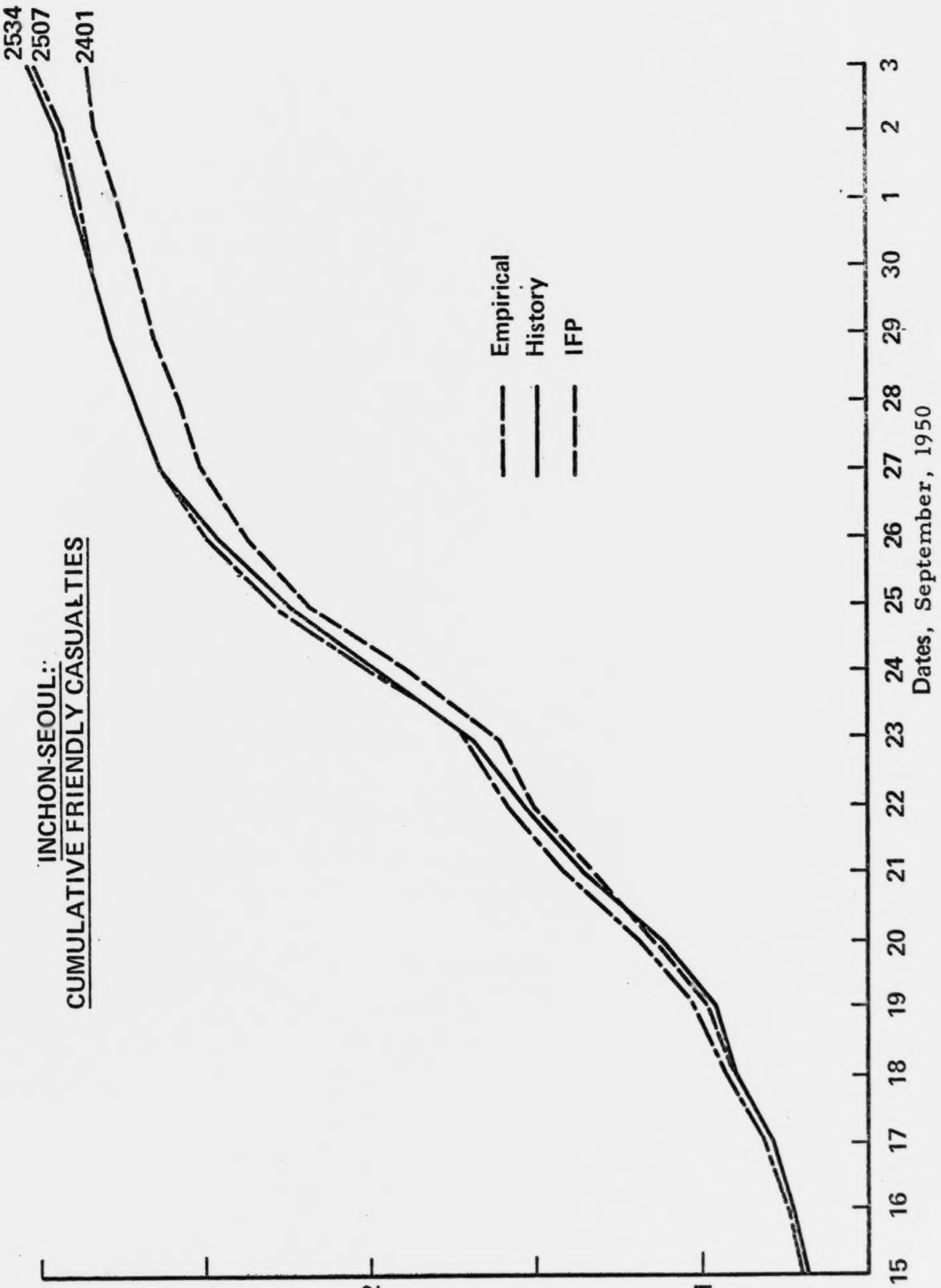
INCHON-SEOUL:
CUMULATIVE FRIENDLY CASUALTIES
Thousands of casualties
3
2
1
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
1
2
3
Dates, September, 1950
Empirical
History
IFP
2534
2507
2401

Figure 5

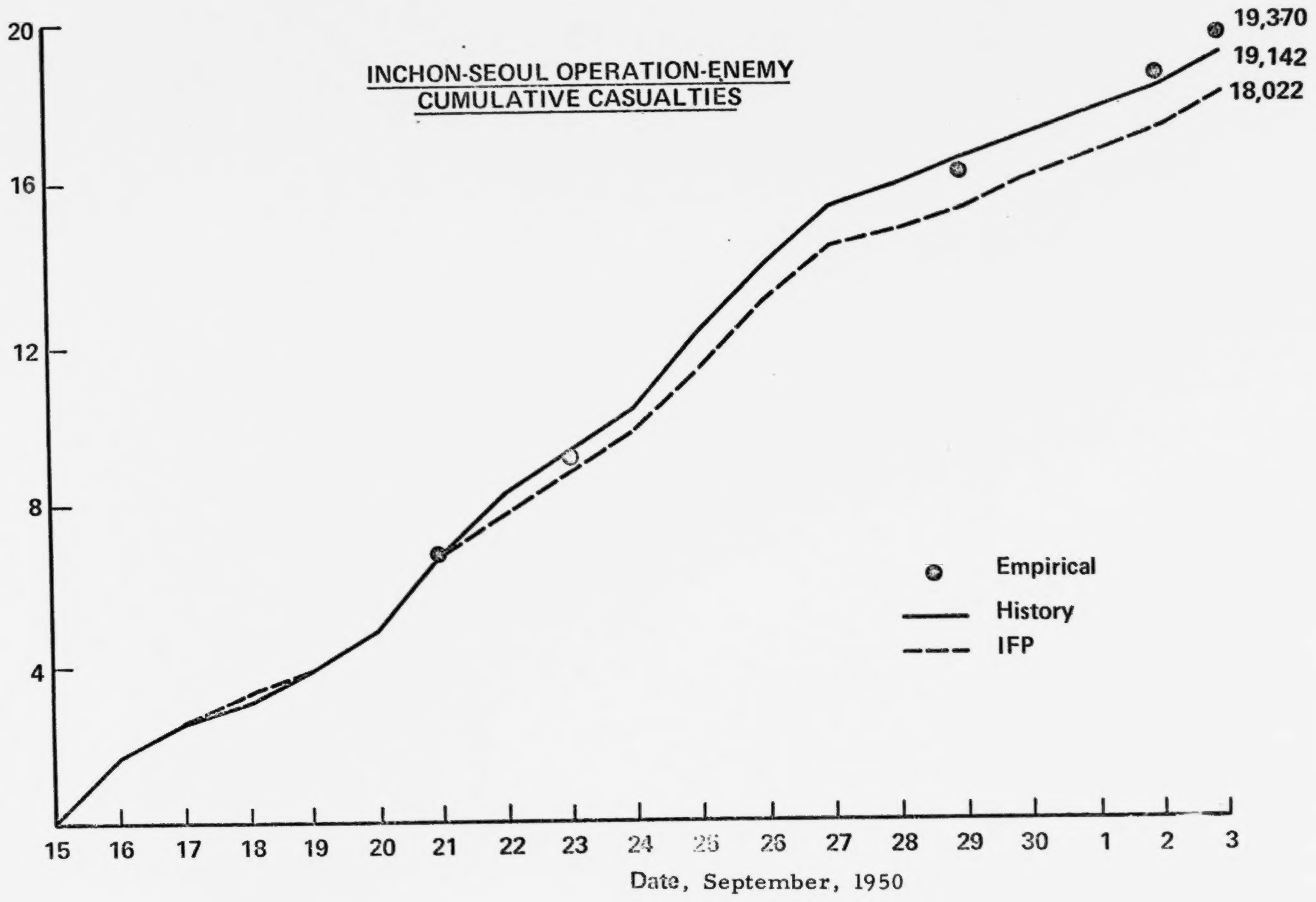
INCHON-SEOUL OPERATION-ENEMY
CUMULATIVE CASUALTIES
20
16
12
8
4
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
1
2
3
Date, September, 1950
Empirical
History
IFP
19,370
19,142
18,022

Figure 6

The first two assumptions relate to the Lanchester type of attrition which is assumed in the TWSP model; i. e., for close combat engagements, the loss of strength of a unit is proportional to the strength of the opposing unit, and for fire support, the loss of strength in the target unit is proportional to the product of the strengths of the firing unit and the target unit. In several historical battles the engagement patterns of the units were determined. By inference the kill rates of each of the involved units were also determined as what they would have to be for each particular engagement to cause the casualties recorded historically if attrition was of the same mathematical form as the model uses. These implicit kill rates per engagement were then averaged over the battle period by type of unit. The war was "replayed" in TWSP with these empirically derived kill rates to determine the cumulative casualties caused by all the units of various types as a function of time. The cumulative casualties in the simulated battles were then compared to the cumulative historical casualties. Since the beginning and end points of the cumulative casualties for the historical battle and the simulation, using empirical kill rates, should indeed be the same (except for slight variations due to the averaging process), the only possible variation from history is in the intervening time period. Tests which involve longer periods of time should be better than the shorter ones as they provide a larger data sample over which to average kill rates.

There appears to us to be no major contradiction between results obtained by the model and warfare of historical record (as represented by the three battles tested). However, confidence in the nature of attrition would be greatly increased if the implied kill rates were to be calculated for the battle engagements according to a mathematical form radically different from that of Lanchester's equations, such as: the loss of a unit's strength being proportional to the fourth power of the opposing unit's strength. This test--or better, a spectrum of such tests--would provide a comparative base on which to evaluate the closeness of the Lanchester results in the simulation to history.

It should be noted that we have used essentially the same type of validation approach that Joe Engel used in his test of the simple Lanchester law with the Iwo Jima campaign data--except where he had only two units in a simple engagement, we have taken a many-unit battle with a complicated maneuver and engagement pattern and disected it down to a level where the Lanchester concepts could be valid and demonstrated that the historical attrition results do not contradict those predicted by the TWSP simulation concepts.
The following table compares results from the three battles:

AVERAGE PERCENT DIFFERENCE: HISTORICAL DATA AND TWSP RESULTS

Battle	Cumulative Friendly Casulaties Per Cent	Cumulative Enemy Casualties Per Cent	
Heartbreak Ridge	13.0	13.0	
Soyang River I	5.6	3.2	Ordinary average
(enemy offensive)	2.8	4.2	Weighted average
Soyang River II	19.4	9.1	Ordinary average
(UN offensive)	7.6	7.2	Weighted average
Inchon-Seoul	3.4	.8	

Relative to the third assumption, that unit kill rates are related to weapon composition, ammunition expenditure, and posture, the data from the Heartbreak Ridge battle and the Inchon-Seoul landing was used to derive theoretical (IFP) kill rates. Note that this is the method needed to arrive at future unit kill rates. The results obtained for this particular battle are considered to be rather good and seem to indicate that the kill rates of units are related to the weapon composition, ammunition expenditure and posture of the invoved units.

The fourth assumption, concerning the adequacy of the tactical options available in TWSP, was tested to a limited extent in the simulation of the historical battles. The options available in the model were found sufficient to put the units into the same engagement patterns recorded historically.

What we have done is demonstrate that TWSP does allow a sufficient range of tactical and maneuver options to match real life behavior and that when tactics similar to those used in real life are employed, attrition of the Lanchester form in TWSP produces casualties that agree reasonably well with casualties of historical record. In comparing the simulation results with the historical we have found that the simulations show no major contradiction with real world warfare experience.

Thus it appears to us that if the model is applied as demonstrated, reasonable synthetic experience will be obtained concerning variations of force parameters for comparison of relative effectiveness, provided that tactical behavior similar to real warfare can be simulated by the analyst.

Thus in this limited sense we feel that the model appears to be valid relative to Korean War historical experience.

Closing Remarks

In closing, let me return to the general subject of validation of models with historical data. If, in considering all of the difficulties and agonies necessary in testing models against historical data, it seems to you that the returns may be too meager to pay for the effort involved, let me remind you of some of the very urgent reasons for undertaking such a venture.

First, as we are all aware, it is necessary to use models of military systems to explore the consequences of alternative decisions since for a variety of reasons it is not possible to experiment with real military systems. Today many models are actually being used to aid real decision making. By and large these models are purely subjective judgments of the people who were involved in their development and use. That is, they are virtually untested against anything but a criterion of "reasonableness."

If these models are false, they can of course lead to false answers and false decisions--this could be very costly to the nation in money, lives and even the future of the country.

The time has come, I believe, to divert at least a portion of the effort devoted to model development and use to an effort to validate the models we have.

"FITTING KOREAN WAR DATA BY STATISTICAL METHODS"

John Overholt
Center for Naval Analyses

FITTING KOREAN WAR DATA BY STATISTICAL METHODS

John L. Overholt
Center for Naval Analyses

Abstract

Korean war data obtained from the records of all services is related to U.N. divisions engaged with North Korean and Chinese Communist troops in central Korea in May 1951. All data was taken from U.N. force records, which contained estimates of enemy strengths, casualties, and weapons. The daily record for each division was considered: the strengths and casualties of opposing forces, the amount of ground gained or lost, and fire support as measured in artillery rounds and air sorties.

Various graphs display changes in individual variables and in combinations of variables, from day to day and with undulations in the battle line as forces concentrated to attack or withdrew. These plots suggested more sophisticated treatment, with the use of multiple regression to fit various proposed relationships. These were relationships between casulaties and probable causes, such as the quantity of ordnance fired, the intensity of the battle, and the exposure of the troops as indicated by ground gained or lost. The two major problems were missing data and the correlation between types of data that probably had a common cause that could not be measured directly, such as the decisions of the opposing division (or higher) commanders to advance, hold, or withdraw, and their willingness to accept casualties to achieve objectives.

Lanchester equations of various types were examined by the incorporation of firepower into the strength and casualty relationships. Some empirical equations were also prepared.

The data and results were presented briefly; this current work will be presented elsewhere in an extended form at a later date.

"INDUSTRIAL MANAGEMENT TRAINING GAMES – THEIR USE AND VALIDATION"

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INDUSTRIAL MANAGEMENT TRAINING GAMES
THEIR USE AND VALIDATION

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Introduction

The training games described in this paper were developed for use in short training courses where the limited time available must be used in its most effective manner if the participants are to fully understand the course material, its application and implementation. Since their introduction, the games have also been used in industrial training programs and in full length college training courses. The nature of the games are such that it is possible for both the uninitiated and the experienced to participate in the same game with the learning experience being commensurate with individual's background.

The games described can be used as training games or in problem solving, two closely related applications that are discussed in that order in this paper.

Training Games

The training games included in the discussion are: Qual-Man-Ex[1] and Qual-Man-Sim[2], which are Quality Control Management Exercises; and Rel-Man-Ex[3], a Reliability Management Exercise.

Objectives

The objectives of the training games are to place the participants in an environment where they must make decisions that have an effect upon the economics and logistics of the system, and directly affect customer and supplier relations. If the player's decisions are incorrect, they must live with the consequences that naturally arise. The advantage of this type of training is that it gives the participants a chance to observe the full impact of erroneous decisions in terms of cost, scheduling, customer and vendor behavior, life cycle costs, and logistics. The interface and conflicts between individual personalities and departmental objectives are also clearly indicated. Since this takes place on paper, the cost of learning these important lessons is contained primarily in the participant's time. It has been validated that the lessons learned are carried over to the real world.

Game Structure

The games are structured around ficticious organizations whose procedures and policies are modeled after actual organizations. The characters also have ficticious names but their actions closely follow those of real world individuals.

In Qual-Man-Ex, the manufacturer of an industrial product is simulated. The policies, procedures and operations are described so that the participant can thoroughly acclimate himself to the surroundings and react accordingly.

In Qual-Man-Sim, a dialogue serves to introduce the participant to the attitudes and philosophies of the characters of the game. The dialogue has a dual purpose, it is also designed to give the players clues to the problems in the organization around which meaningful problem solving discussions in the form of seminars can evolve.

Rel-Man-Ex is structured around industrial organizations competing for the right to develop and produce an electronic system for sale to the government. The game is designed around the concept of life cycle costing.

Method of Play

After a suitable briefing and familiarization with the rules of the game, the procedures, policies, and modus operandi of the organization, the players of Qual-Man-Ex and Qual-Man-Sim are divided into teams and assigned roles in the organization. These assignments tend to bring the players closer to the problems and objectives of the pseudo-organization and result in a more realistic game.

A series of problems are then given to the players in chronological order. The fact that they react in the same way an individual in the real world would react to such a problem, is constantly being validated. Pitfalls similar to those in the real world are always present and stand in the way of the solution. Information in the form of records, reports, history and analysis are sometimes available. But if they fail to recognize the correct solution, a more serious problem in the future results, again a parallel to real life. In such cases, the penalties are usually more severe, i.e., more costly.

One of the features of Qual-Man-Ex is its computer application. For certain problems the players can build a model to predict the effect that their decisions have on future operations and costs. Again the purpose is twofold: it allows them to study the effect of their decision on the system without committing themselves, and also gives them an appreciation of how computers can assist them in decision making.

The game is scored by recording the cost of the decisions made and the cost of the time needed to arrive at a solution.

In Rel-Man-Ex, the method of play is built around an electronic system for which the government has issued a request for a proposal. The players acting as designers, planners, contract and procurement officers, and reliability, and production engineers assemble a proposal that includes the development, testing, production and one year's maintenance cost of the equipment. The government team, also selected from the players, acting as a Source Selection Board (SSB), selects the contractor using the criteria they have established. After the winning contractor has been selected, all contractors are given a development and production contract to validate the correctness of the government's selection. Unexpected problems and situations arise during the development, production, testing and field usage stages of the system life cycle.

The total amount of money spent by the teams on development, testing, production, maintenance and problem solving serves as a score for the team.

Problems

To illustrate the types of problems encountered in Qual-Man-Ex and Qual-Man-Sim, let us suppose that the players are told that an electrical item has been returned by a customer because it was incorrectly labeled. The label should have shown a lower electrical capacity than was actually stated. This is all the information given to the players. The course of action they follow from this point on depends upon their problem-solving ability. The game monitor has a list of the decision points that the teams are expected to investigate. Flow charts have been developed for the game monitor's use so that he can keep track of their progress. See Figure 1. (For computer score keeping, the flow chart also serves as model for writing the computer program.)

At each decision point, the monitor notes the team's decision. If it is incorrect or missed completely, a penalty may result which will be either mild or severe depending upon the nature of the oversight and chance since a random number generator is used to select the appropriate consequence.

For Rel-Man-Ex, the initial problems are player-oriented. This means that they create their own problems which can be traced to an incomplete or improperly worded specification. The design can also get them into trouble if they fail to properly coordinate the design with the testing plans, or their test plans can get them into trouble.

As the game proceeds, other problems arise. For example, suppose that a system is designed with a failure rate of 1.3% per 1000 hours on one of its sub-contracted items. Qualification tests on the item indicate that the actual failure rate is running near 2% per 1000 hours. The players must now decide upon how to solve the problem and will most likely consider a design change, a specification change, derating, etc.

Each problem is designed to emphasize a certain aspect of quality control and/or reliability decision making. The problems used are real world problems that have been adapted for use in the game.

Lessons Learned

Because of the close similarity between the problems used in the game and the real world, the players are able to relate the experiences in the game to their jobs. This carry-over serves to validate the fact that the historical data used in the game problems can be usefully employed to teach problem solving techniques.

We can also validate the fact that human response and reaction in the gaming-simulation closely resembles the real world. Hence, the play may gain an insight in regard to human behavior problems.

We can also validate the fact that group problem solving, if properly conducted can provide meaningful solutions. However, group dynamics have repercussions that have been demonstrated in both the game and the real world.

Many other traits of human behavior in problem solving have been validly observed in the game and in the real world. They include such things as, surface solutions where the broad picture is discussed, but the details are left for someone else to derive; anxiety, where haste replaces methodical correctness; pressure decisions, where the individual reverts back to his former method of problem solving when under pressure; inadequate training in basic methods where the individual does not know when or how to begin; snowing, where the individual talks a lot but doesn't say anything; forcing, where the individual with the loudest voice can force the decision even though he may be wrong; assuming, where invalid assumptions are made and lead to incorrect decisions; and shallow decisions where the individuals simply do not dig deep enough into the problem.

In most of these situations, the game can be used as the vehicle to teach the individual how to overcome these deficiencies through the use of realistic penalty problems that emphasize the cause of the problem. In each of these areas, there is a strong similarity between real life and the game.

Problem Solving

As a problem solving tool, a game is designed by the individual that closely resembles the real world where the problem exists. Depending upon the problem in questions, the individual may build a computer model and let it operate over a period of time and observe the effects for different values of the parameters.

Or, he may choose to incorporate human responses by having humans participate in the solution to a problem under controlled conditions. Upon observing their response, a solution may be found that could not otherwise be derived except under actual conditions.

This application of gaming differs from training games primarily in organization being simulated. As a training tool, a ficticious organization may be used as a model. In problem solving, the organization is designed to represent the specific organization in which the problem exists. The outcome contributing to the problem will be closely allied to the outcomes observed and validated for the training game previously discussed.

Summary

The success of the game has been validated by the response of over one thousand individuals who have participated in the games during the past seven years.

One of its main advantages is that the players receive feedback after making a decision so that they see firsthand the effect of their decisions. They can also experiment with alternative approaches to problem solving that might otherwise go untried.

The games also provide the manager with an excellent vehicle for judging the competency of his personnel and also indicate where they are weak and where they are strong.

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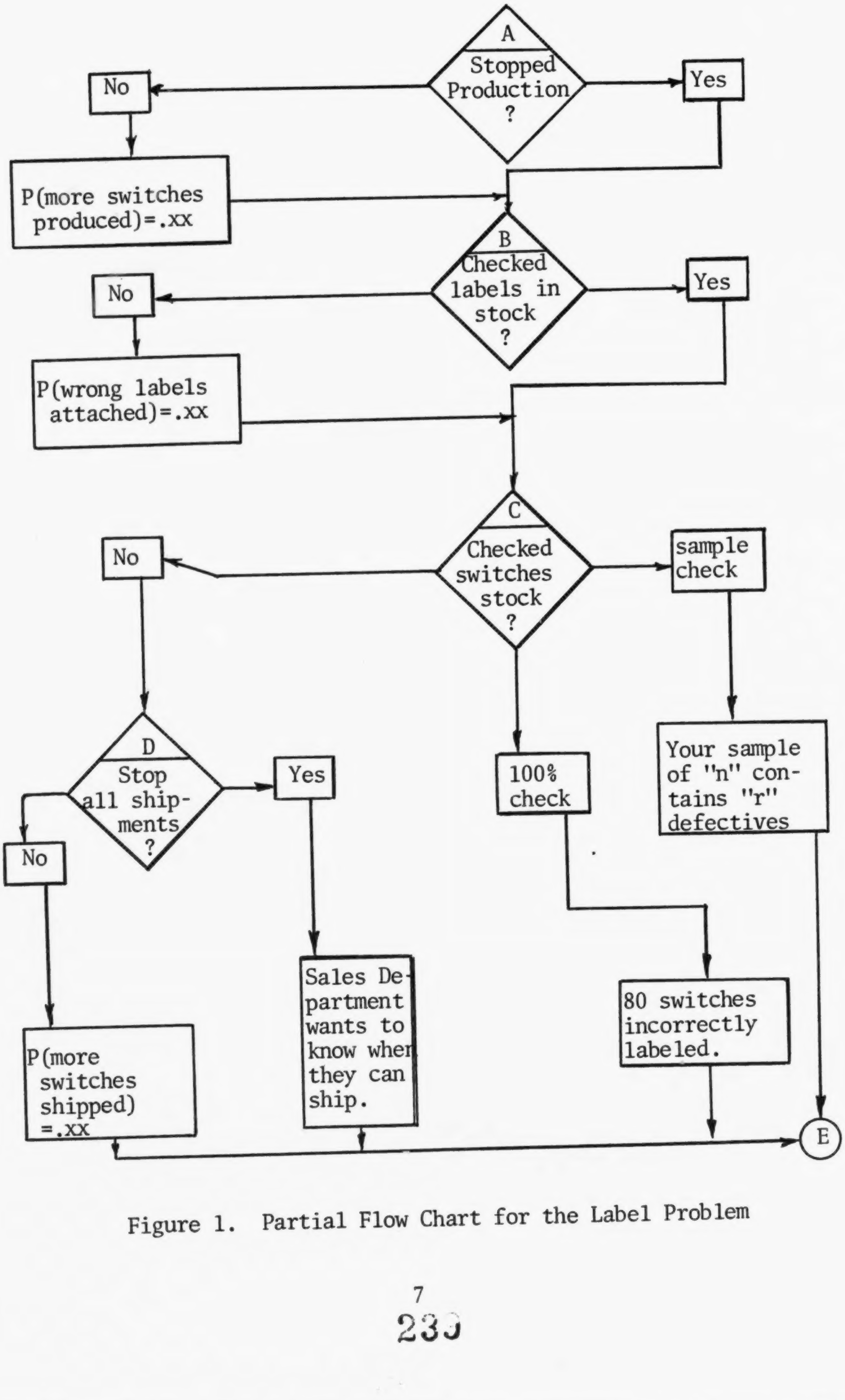
A
Stopped Production ?
No
Yes
P(more switches produced)=.xx
B
Checked labels in stock ?
No
Yes
P(wrong labels attached)=.xx
C
Checked switches stock ?
No
sample check
100% check
Your sample of "n" contains "r" defectives
D
Stop all shipments ?
No
Yes
P(more switches shipped) =.xx
Sales Department wants to know when they can ship.
80 switches incorrectly labeled.
E

Figure 1. Partial Flow Chart for the Label Problem

"MODELING THE FIRE PROTECTION DELIVERY SYSTEM"

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THE USE OF GAMING TECHNIQUES IN MODELING THE FIRE PROTECTION DELIVERY SYSTEM

a paper presented to
THE NATIONAL GAMING COUNCIL

NINTH ANNUAL SYMPOSIUM
APRIL 1970

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MAN AND FIRE

Since prehistoric times, man has been vexed by the double-sided nature of his sometime servant, fire. Although great technological benefits have accrued to man from the controlled use of fire, he has also had to contend with the unpredictability of its accidental outbreak and spread. Even before man had harnessed fire for his own use, he was treated to displays of natural whimsy as conflagrations were unleashed by lightning lacing down to dry forests or by volcanoes spewing forth ashes and hot lava. Certainly events as these could be considered little else than "acts of god" and beyond human control.

Fire has become an integral part of our civilization. Almost all of our electric power is generated by the combustion of fossil fuels. Fire powers our automobiles, ships and planes, cooks our food, heats our homes, plays a vital role in many of our industrial processes, and performs a multitude of other tasks. But it is also the cause of death, injury, destruction and sorrow. With all our intellectual and technical resources, we have been unable to effectively control our useful capricious servant, fire.

> *August 12, 1953*
>
> *"General Motors Corporation Plant - Livonia, Michigan, Sparks from an oxy-acetylene cutting torch ignited drippings in a 120' long conveyor drip pan. Several thousand gallons of flammable liquids plus 2000 tons of tar and asphalt on the roof were the fuels for the fire that destroyed the undivided 34.5 acre supposedly 'non-combustible' building. 4,200 employees were forced to evacuate. Six dead- 15 injured- and a property loss of over $50 million. The estimated loss to the economy in the form of sales - $750 million."*[1]

Why?...Why must society continue to endure such an enormous loss from fire? Are these losses inevitable, just as the lightning ignited forest fire was inevitable? Is there nothing we can do to curb this mounting erosion of life and property?

The answer is a resounding YES. The reality of the matter is that we do have some measure of control, through a scale of decisions that have an influence on a daily to long-range basis, over fire and fire protection.

---

[1] National Fire Protection Quarterly-October 1953

Statistics indicate that fire is basically an American problem. According to the statistics in the November 1967 Fire Journal (these figures include all fires for most countries, but the exceptions make direct comparison impossible), America suffers the highest loss per 100,000 population and the highest property loss per person of any of the eleven countries under survey. (see figure 1). The United States life loss rate, as determined from these figures, is 20 times that of France and even higher in comparison to a few of the other European countries.

	Death Per 100,000	Dollar Loss Per Capita
DENMARK	1.0	5.20
ENGLAND	1.7	4.00
FINLAND	2.5	3.50
FRANCE	0.33	3.60
GERMANY	*	3.25
ITALY	0.2	1.00
NETHERLANDS	0.4	2.70
NORWAY	1.0	5.00
SWEDEN	1.75	6.00
SWITZERLAND	0.37	1.70
UNITED STATES	6.2	9.50

Figure 1: COMPARATIVE FIRE LOSSES
* data not available, no fire casualty statistics reported.

The problem of fire protection expands in all directions at once. The people and institutions involved in the protection of a single piece of property extend across a neighborhood, a city, even across the nation. If the level of fire protection that exists today is not as high as it could be (and certainly not as high as we would like it to be), what can be done about it? Where does the responsibility for our mounting losses lie? Are they the result of ignorance; insufficient knowledge of the nature of fire, building materials and methods; the actions or activities of people and processes that inhabit or utilize our structures? Perhaps it can be traced to negligence?...economic considerations of self interest could play a part...shortsightedness...or an unfortunate combination of circumstances ...are these the reasons for our failure?

> January 9, 1970
>
> "... A fire in the Harmar House Convalescent Home, Marietta, Ohio, claimed 21 lives and injured another 23. Fire-fighting efforts were hindered because fire hydrants had frozen in the six-degree weather. The building was described by Governor James A. Rhodes as 'a first-rate institution', but dense, black smoke from carpeting, padding

*and wall coverings filled the buildings and was the cause of 21 deaths."*2

Who can we blame? The architects who design our physical structures? The owners, who are often most interested in promoting their own financial interest rather than providing fire safety in their buildings? Building code officials, whose enforcement of the regulations and codes is not as strict as it could be? The fire departments...? The insurance companies...? The occupants of the buildings, whose actions (or inactions) can negate almost all other measures undertaken for their protection.

Who can we blame?

TRADITIONAL RESPONSE

Man has always recognized the need to protect himself from fire. One of the earliest efforts to deal with the problem is found in the Code of Hammurabi which dealt with conditions in Babylonia around 2100 B.C. Roman law also applied restrictions to buildings and city planning.

Approaching the problem in a number of ways, man has evolved a structure of people, institutions, procedures, policies, and devices that all work to provide a certain level of fire protection. Over time this structure has undergone many changes, and much of our present knowledge and practice has been hard, and sometimes tragically won. Decisions on fire protection were made by people who honestly believed their courses of action held the key to a valid solution. Unfortunately, however, insufficient knowledge, resources, and communication; circumstances; and human fallibility seem to thwart our best efforts- resulting in astonishing losses of life and property.

After the great London Fire of 1666, much of the reconstruction was controlled by the Rebuilding Act of 1667, which prescribed not only the types of houses that could be erected in the various parts of the city, but also the materials and methods to be used in their construction. Unfortunately, however, many people consider a building that complies with contemporary code requirements as fire safe, although many tragic fires have demonstrated that mere code compliance does not insure adequate fire protection.

---

2 Albany Times Union, January 10, 1970

Fire departments are established to combat and contain fires that do occur, in most cases with water from a publically owned distribution system and with apparatus traveling over publically maintained roads and highways. But it must be realized that reliance on the Fire Department's fire-fighting capabilities IS A TACIT ADMISSION THAT ALL PRECEEDING FIRE PROTECTION EFFORTS HAVE FAILED.

What can be done to persuade people to undertake fire protection measures? Ideally, the most important incentive should be the prospect of saving lives, and concurrently, property. We must, however, approach fire protection on a cost-benefit basis. Life and property safety cease to be effective incentives as costs skyrocket. Our admittedly limited personel and societal resources must be effectively used through balanced design; to lower losses we must produce more protection per dollar spent.

To date, all the combined efforts of our society have not been very successful. The major reasons for our less than adequate performance in the field of fire protection can be summarized as follows:

1. Traditional efforts have been uncoordinated and piecemeal, often the results of a panic-induced reaction to a single manifestation of the larger problem of fire protection.
2. There is no evidence of the existance of a total understanding of the extent of the problem of fire protection and of the socio-economic, governmental and technological contexts within which it operates.
3. An erroneous belief that current efforts, if zealously pursued to their logical end, are the answers to our problem.
4. A level of complexity within the existing structure of fire protection that makes innovation and change difficult, if not impossible.
5. Research efforts biased to favor a vested interest yield a distorted picture of the actual situation. For example, studies and publications sponsored by manufacturers and trade associations tend to favor approaches to fire protection beneficial to their own interests.
6. Failure of our people, corporations, and institutions to balance financial gain against less tangible but more important human and social costs.

What is needed is an entire re-thinking of the fire protection system. That is - a new approach to fire involving changes in the basic philosophy of prevention as well as the physical requirements demanded by our buildings.

There exists today an operating mechanism which seeks to provide fire safety to the American Public. We have called it the Fire Protection Delivery System (FPDS); and it shall be defined as...

> *...that system within society comprised of all those people devices, institutions, conditions, and interrelationships that work towards providing fire protection for human life, a single building, or the entire community.*

■ UNDERSTANDING THE FIRE PROTECTION DELIVERY SYSTEM

If a society is dissatisfied with the magnitude of its losses, what can it do to reduce them? The answer may lie in the nature of the FPDS itself: is the general approach to fire correct? ... or must it be changed and a new direction be taken? ... or the answer may be in the inefficient utilization of the existing system: are the current controls being properly applied? ... is some part of the system inadequate? ... How can the FPDS be made to yield the level of protection which is desired?

The first step towards achieving an understanding of the Fire Protection Delivery System is to collect and isolate the elements of fire protection. The location of these elements within the system is determined by the strength and quality of their relationships with the other components. If it were at all possible to identify all the components and their relationships within the FPDS, one could simulate its workings, and ultimately find ways to optimize its output.

The FPDS is a complicated animal, and fourteen areas of relevance have been identified in an attempt to understand its workings. A sampling of questions to be considered in each area are given in the following list.

1. CHARACTERISTICS OF FIRE AND FUEL

Fire- conduction, convection, radiation, patterns for spread, gases, emits light, heat and sound

Fuel- combustibility, flame spread, fuel load, smoke odor and gas potential

2. DETECTION AND ALARM

Human or Automatic- sensitivity, reliability, limitations, and reaction time. Internal or external alarm. Detection devices are useless without alarm or extinguishment modes.

3. ESCAPE OR REFUGE

Escape- separation of occupant from burning building
Refuge- retreat to fire safe area within the building

4. CONFINEMENT, CONTROL AND EXTINGUISHMENT

Contain fire to original area of ignition
Intermediate step to extinguishment
Agents- occupants, buildings, or professionals
Devices- cooling, removal of oxygen, removal of fuel, or interruption of production of conbustible gases

5. OCCUPANCY- PERSON

Characteristics peculiar to a specific occupancy (use)

6. OCCUPANCY- THINGS

Physical, movable objects (hazards)...deterioration, furnishings

7. PHYSICAL STRUCTURE

Internal integrity, question of structural protection, deformation and stability
Permanent but non-structural (non-load bearing walls)
Mechancial systems

8. EXTERNAL ENVIRONMENTAL FACTORS

Man-made- adjacent buildings, heat transfer, wall openings
Water supply- amount, pressure, reliability, proximity
Fire Department- capacity, reaction time, traffic and roads, ability to maneuver once at site, degree of training
Disruption of Public Life- transportation, utilities, facilities, question of taxes, interference from crowds
Real Estate Market- supply and demand for space
Natural Factors
    Climate- winds, daylight or darkness, rain or snow, temperature
    Geography- ground conditions, earthquake zone, topography

9. WRITTEN REGULATIONS AND ENFORCEMENT

Enactment, licensing, codes, zoning
Building Permit- review of plans, Certificate of Occupancy
Interpretations- competancy, experience, supervision, graft

10. MAINTENANCE (NEGLECT)

Operation of devices, supervision over fuel loads, awareness by occupant

11. HUMAN FACTORS

Physical- mobility, hearing, vision, smell, disorientation, age, health status, required assistance, tolerance factors for heat, smoke, gas, shock, reaction time...

Psychological- instinct for self-preservation, to control the fire yourself, confusion, panic, preservation of heritage, carelessness...

Collective Community desires- politics tied to local economy and the social effect of fires

12. INSURANCE

Based on probability of loss or damage. Questions of liability, initial investment vs. premiums, expendability

13. EDUCATION

Always continuing process...create an awareness and concern

14. FIRE RESEARCH AND INVESTIGATION

Testing methods, pre-testing, component testing, system testing, human reaction testing

It becomes quickly apparent that this outline in no way exhausts the complexity of the FPDS. This list of relationships, facts, conditions... breaks the system into a relatively simple form. No where does it explain what part it plays in the total picture - that is, how one element relates or effects the other, or how they all fit together in the system.

A very important component of the system is the people who make the decisions and the people who feel the consequences of those decisions. There are many persons and groups (architects, engineers, building inspectors, insurance agents, city officials... and so on down to the owner) who play particular roles in the fire problem. Each of these players makes certain decisions, each of these decisions carries ramifications, and each of these ramifications has an effect on many of the other previous or concurrent decisions. The problem is not relating the people to their actions or inactions, but bringing them all together in order to investigate and comprehend the outcome of their interrelationships. However, these people are not necessarily concerned with the same things, and may not even be interested in what they believe to be the other person's problem. The complexity of the investigation further increases; for not only is it difficult to conceptually bring all these people under the same roof, but the roles they play and the level in which they participate depend on when, where, and how they interrelate with all the other components of the system.

Our understanding of the complicated and changing factors and how they interact with each other is hindered by our limited ability to devise conceptual methods in which they can be accommodated. Confronted with this problem of understanding, we saw a possible course of action: synthesizing all the available information into not just a workable model, but a system simulating game.

■ RESEARCH OBJECTIVES

Our goal is to construct a game patterned after the observable components of the existing FPDS. If we are successful, we then intend to take the information gained from such a game and use it to produce what we have called a Decision Consequences Guide... (i.e. prediction tool)... that is, a means by which any individual could reference (in advance) the measurable results of his actions or inactions concerning the fire safety of any architectural situation which happened to be in question.

As an intermediate goal, however, the game could act as a heuristic device; familiarizing students, researchers, potential sponsors, and participants playing their real-world roles when possible, with the intracacies of the fire problem.

We want the game to reflect the importance of something more than a monetary balance of resources and an efficient return on investment. It should include a "social-societal-humanistic" value... It should reflect a concern for potential loss of life, for inconvenience, for loss of income, for loss of home... It should include human-psychological factors, such as carelessness, (propped-open fire door) illusion of non-involvement ("it can't happen in my home") or shifting the burden of responsibilities ("oh, they will take care of it") when there just isn't any "they" to do the job... It should include things that shouldn't happen and that have no reason to happen, yet still do occur. It should take into account the collective-community attitudes, if there are any- or the fragmented neighborhood feelings if there isn't any community identity.

■ FIRE!

The development of our game, called FIRE! has advanced from an embryonic stage (its first run was in late February) to that of providing a basic operating community framework to which we are in the process of adding the various identifiable fire-related decisions. It has been adapted from Dr. Allen G. Feldt's Community Land Use Game (CLUG) developed at Cornell University, with an attempt to extract some of the community operating economics into the hands of the game moderator and to assign to the building owners a wider range of responsibilities and decisions with respect to each of their investments.

To give you a quick idea of what it is all about, put yourself in the role of an owner about to construct or renovate a building:

-how much money could you afford to spend, based on how much and on what terms the bank is willing to make you a loan?

-for what are you going to use your building? ... do you have a tenant?

-what type of construction should you use?

-how much effort and cash are you willing to apply to the problem of fire protection?

-what do you intend to do about fire insurance? (which by the way includes every other factor here-only translated into money)

-are you going to apply pressure on the Dept. of Public Works to maintain and improve the public water supply?

-are you concered with the capabilities of the city Fire Dept.?

-will your architect have to follow existing and possibly outdated building codes? ... or does he have the freedom to work with some comprehensive reference resource to achieve the intent of those codes?

-what about neighboring properties? Has the Building Inspector let their owners allow them to deteriorate?

-are you willing to make daily inspections to catch the human-psychological actions of your tenants and take steps to off-set their effects?...

...and the same type of list can be generated for you the architect, you the engineer, you the fire chief, water commissioner, zoning officer, police chief, building inspector, city planner, mayor, occupant, user, passer-by, wife, husband, or child.

We have defined and are continually identifying these and other decisions and decision makers from just being concerned with and concentrating upon the problem of fire in contemporary society. FIRE! we hope will permit us to study these relationships and interactions and provide a basis for the construction of a Decision Consequences Guide.

In its current form, the game allows the owner-player a limited range of decisions related to his building. The first and obvious alternative is Building Use.

He has the option of five types of buildings: private residence, apartment house, industry, office or commercial; each having a characteristic base construction cost and each rated for probability of fire outbreak - measured in what we call FIRE POINTS. The owner may then choose from one of four construction types: Fire-proof, Fire-resistant, Fire-protected or Non-protected -again, each having a construction cost multiplier relative to the base construction cost, and each construction type reflecting a correspondingly higher or lower number of FIRE POINTS.

Mechanical Devices such as internal or external alarm systems and extinguishment systems are available for installation in either new construction or buildings under renovation at a given price and yielding a concurrent fire safety benefit. Management and inspection services may be contracted for and Insurance is available on a scale that is reflective of all other fire related characteristics presently under consideration.

A building owner-player must also consider the proximity to his site of water hydrants and the municipal fire house. He must take into account the traffic conditions of the roads servicing his site. An owner-player is given the option of allowing his building to depreciate -thus increasing his net income, but also increasing his chances of fire loss. He is also forced to respond to the effects of a changing tenant market with resulting changes in building fuel load. There is an inclusion of unknown random factors called Site Characteristics (a broken water main, bad weather conditions, interference from crowds, etc.) over which he has no control, yet still feels the effects.

The players have a TOWN MEETING periodically not only to vote on water main installation and setting the tax rate, but to consider such questions as road improvements, additional fire houses, building codes, zoning ordinances or the establishment of fire districts, etc.

In its current form, all costs and benefits in the game exist at, or are translatable into, a monetary scale. Future versions will attempt to incorporate a life and injury factor as well, which will probably be included when we are able to add occupant-players to the game.

■ CONCLUSION

Our position is that of a novice. Everything we collectively know about gaming has been learned within the past six months. Our purpose in coming to this symposium is two-fold: first, to present to you what we believe is a new and somewhat interesting application of gaming theory to a very serious and pressing social need; and, secondly, but perhaps more immediately important, to ask for your reactions and suggestions and perhaps even involvement, concerning the application of gaming techniques as an aid in understanding the Fire Protection Delivery System, and as a first step towards providing a reasonable degree of life, property, and community safety at an acceptable level of cost.

Your comments are invited. Address all correspondence to: FPDS. Center for Architectural Research, Rensselaer Polytechnic Institute, Troy, New York 12181.

"SIMULATION GAMES IN SOCIAL SCIENCE TEACHING AND RESEARCH"

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SIMULATION GAMES IN SOCIAL SCIENCE TEACHING & RESEARCH: AN INTERIM REPORT

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Simulation games, characterized by the replication of key features of some aspect of the real world as a context for a contest according to set rules, have long been used for education and research. These games have taken different forms and emphasized different purposes in different cultures. Until recently, their principal use in the post-Renaissance West has been to serve as an adjunct to military training and research in the form of war games. The RAND Corporation's political/military games, originally developed in 1954, and various management games, designed and used by business schools since the 1950's, expanded the traditional Western concern to include a broader spectrum of the social sciences. Simulation games have since met with enthusiastic acceptance in many social science fields, although those related to international relations and business education have been in use for the longest period and comprise the bulk of present empirical evidence now available, and hence the bulk of that which forms the basis of the present paper.[1]

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1. On the distinction between simulations and games see Sarane S. Boocock; "From Luxury Item to Learning Tool: An Overview of the Theoretical Literature on Games," Simulations Games & Learning, ed. by Sarane S. Boocock and E. O. Schild; Sage Publications, Inc., Beverly Hills, California; 1968. On the role of games in different cultures, see Roger Caillois; "Man, Play, and Games"; The Free Press, New York, N. Y.; 1961. Several sources treat the development of war gaming; e.g., John P. Young; "A Survey of Historical Developments in War Games"; Operations Research Office, Johns Hopkins University, Bethesda, Maryland; 1960. Clark Abt; "War Gaming"; International Science and Technology; August, 1964, pp. 29-37; and Clayton J. Thomas; "Military Gaming," in Progress in Operational Research, Vol. I, ed. by Russel L. Ackoff; John Wiley & Sons, Inc., New York, N. Y.; 1961. On the RAND development, see Herbert Goldhamer and Hans Speier; "Some Observations on Political Gaming," in Game Theory & Related Approaches to Social Behavior, ed. by Martin Shubik; John Wiley & Sons, Inc.; 1964, pp. 261-272.

With fifteen years of experience one might expect that we would know quite a bit about the efficacy of simulation games in social science research and education, but we don't. What we do have is an inventory of often contradictory propositions about their value. While often based upon first-hand observation, these propositions are seldom if ever the result of scientific study. This is beginning to change. As Sarane S. Boocock has pointed out, the field of simulation gaming has passed through three phases since the 1950's: acceptance on faith through 1962 or 1963, a "post-honeymoon" period during the years 1963 through 1965 when the first crude attempts to evaluate games led to inconclusive results and disenchantment, and the present period of "realistic optimism" based upon accumulated experience and further experimentation.[2]

This paper, an interim effort, attempts to synthesize the existing empirical evidence concerning the utility of simulation games in social studies teaching, training, and research. Our data are drawn from several sources: published literature dealing with simulation games, descriptions of simulation games in use, communications with fellow gamers, and our own experience with the design and use of simulation games for education. At the moment, the best we can do is to offer a preliminary codification of the present confusion through a delineation of the independent variables that seem likely to be related to the costs and benefits of simulation games and of preliminary assessment and their advantages and disadvantages. Our final study will attempt a more rigorous causal connection between the two sections of the present paper based on an extensive survey effort that is now under way.

A Taxonomy of Simulation Games

A delineation of potentially significant independent variables must begin with "purpose" which both affects and defines the dependent variables developed under "Advantages" and "Disadvantages" below. The purpose of simulation games may be either to teach, to impart knowledge and understanding of a body of information or to inculcate a set of attitudes or a system of values relating to the social system; to train, to impart a set of skills relative to the manipulation of the social environment; or to contribute to research, to lead to the discovery or confirmation of the possibility of probabilistic social contingencies, of the utility and/or operationality of social concepts, or of the existence of general principles concerning the social universe. These objectives are by no means mutually exclusive; yet not all games serve all objectives. Certainly most games do not serve them all well. For example, as a teaching tool, the value of a game to students may increase when its scope is enlarged, while the value of that game to those interested in policy-oriented research is degraded.[3]

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[2] Sarane S. Boocock and E. O. Schild; "Introduction," in Simulation Games and Learning, ed. by Sarane S. Boocock and E. O. Schild; Sage Publications, Inc., Beverly Hills, California; 1968, pp. 13-26.

One may characterize simulation games by their structure. The rules of the game, or lack thereof, are crucial to that structure. James S. Coleman has categorized game rules as:

1. goals developed by and/or imposed upon the participants
2. environmental response rules, wherein the rules substitute for that portion of the social system not directly represented by the participant teams in the simulation
3. procedural rules, describing how the game is to be put into play and the general order in which play proceeds
4. behavioral rules, corresponding to role specifications, describing what the participant can and cannot do
5. police rules, outlining the consequences of breaking one of the game's rules[4]

The principal simulation games vary according to the abstractness, detail, scope, restrictiveness, source, and time of specification of each of the above.

The rules of INS, the most widely used of the present international educational simulations, are quite abstract and detailed; but the detail still allows great flexibility by both the control group and the participating teams. POLIDOX (political paradox), the principal international simulation game now in use at the Air Force Academy, is as abstract and only slightly less detailed in its rules. Flexibility remains high. POLIDOX contains a unique feature in the area of goal-setting. Within limits, the student teams create their own "national interest" at the beginning of play and then are graded according to the congruence of "international" outcomes to that interest. By contrast, the Joint War Games Agency (JWGA) games do not set up a complex, detailed rule framework. Rather, most of the guidance affecting the flow of the game is ad hoc, flowing almost solely from the good judgment and experience of the control group. The early RAND games and the POLEX games at MIT follow a similar pattern.

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[3] Goldhamer and Speier; p. 272.

[4] James S. Coleman; "Simulation Games and Social Theory"; Report Number 8 of the Center for the Study of Social Organization of Schools, Johns Hopkins University, Baltimore, Maryland; 1968, pp. 6-10

The simulation game universe is comprised of more than rules. The living portion of the game structure can be categorized and compared at three levels: the team system, the internal structure of the teams, and the participants that make up the teams. Team systems can be characterized by their abstractness, the number of actors directly represented, inter-team internal homogeneity, the distribution of power and other attributes, and the communication systems provided to the teams. The system represented in INS is quite abstract, as is the one in POLIDOX, although both may be structured to approximate the power distribution and other attributes of an historical system. The POLEX, RAND, and JWGA systems are less abstract in the sense that the actors and their power relationships are as they are today, but the actors are frequently called upon to deal with a set of hypothetical events. Dangerous Parallel, a crisis game developed by the Foreign Policy Association, is at once more abstract and more concrete. It is a disguised simulation of the outbreak and conduct of the Korean War. Empire, an international trading game designed by Abt Associates, Inc. to increase understanding of the trade relations in the British Empire circa 1735 is the most concrete of all. An historical system is explicitly created and rigidly controlled to conform to the situation then extant.

The internal structures of the teams vary as much as do the team systems from game to game. However, for purposes of research into the efficacy of simulation games, the formal structuring of teams may not be an important variable. It seems to have less impact on behavior than does the formal structuring of the system. Regardless of role and decision rule specifications, teams tend to fall into unique organizations based on informal relationships developed prior to or during play.[5]

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[5] Reported several places in the literature, and experienced at the Air Force Academy games.

Finally, the structure of simulation games differs according to the type of participant. Participant characteristics vary from game to game. INS, for example, has been played with facility by homogeneous and heterogeneous mixes of participants ranging from grade school to post-graduate level, from layman to expert, and from aggressive to cautious personality types. On the other hand, a game like Empire is definitely best suited and normally used to educate participants at the elementary and secondary school levels.

Dynamic, interactive characteristics of games differ as much as those of structure and should, it would seem, be as important to learning outcomes. Initial scenarios can be dichotomized into crisis and noncrisis situations. In INS and POLIDOX crises, if they occur at all, are developed out of the internal dynamics of the game, while crises are imposed at the outset in POLEX and most high-level policy games run by the JWGA. Once any game begins, interaction can be influenced by the role assigned to the control group, either active or passive. If assigned an active role, the control group can direct communication, inject nonteam generated inputs into the system, and otherwise guide the flow of the game. Other important influences on the nature of interaction are the ease and means of inter- and intra-team communication; the number, length, and spacing of play periods; the privacy of team areas; the permissible instruments and arenas of interaction; the tempo of game time; and several other factors, many of which have little to do with the particular game being played and much to do with the immediate circumstances surrounding a particular play.

Much needs to be done to specify which of the variable characteristics of games and their settings may be significant for learning and research outcomes. These characteristics would be the independent variables in the rigorous experimental work that needs to be accomplished. A preliminary survey of the literature does reveal a few, which will be touched on later. Generally speaking, however, most claims to the advantages or disadvantages of simulation games do not bother to specify conditional factors such as particular simulation characteristics and situations of use.

Advantages

Supporters claim that games remove certain impediments to learning that occur, especially, but not exclusively, at the secondary school level:

> Dr. Coleman has pointed out the learning advantages that result when penalties are imposed by rules of the game or peers instead of by authority figures. Too often rebellion or hostility toward adult . . . society interferes with learning . . . . In the

> simulation environment the teacher is without authority, often a mere bystander; so whatever lessons students learn come from the game itself.[6]

Not only must the student be freed from a motivation not to learn, he must also be motivated to learn. Simulation games have been highly praised for their facility in motivating the student to become more active in the game, and hence to learn whatever there is to be learned directly from participation; to go beyond the game during its play by reading substantive material in depth so as to learn how to survive in the game; and to continue to delve into the substantive material after the game is over because of the new interest evoked by the game through involvement and a new sense of efficacy. Examples of all these behaviors are to be found in the literature. Most sources agree that the first type of motivation leading to active participation is normally exhibited.[7] With regard to the second, one finds such favorable reports as "some students were more willing to read books like The Federalist Papers [in the U. S. History simulation "Disunia"], since the knowledge used from such reading could be used in the game." Similarly, in another game setting, students have sought information beyond the curriculum to help them succeed.[8] Evidence of the third type of motivation is contained in the following observation made about an international relations simulation undertaken at University College London:

> The odd student that inevitably gets into a class and who is not greatly interested soon becomes involved in simulation--and he turns up to other classes because his interest is stimulated.[9]

Aside from being motivated, what does the player of a game learn from the simulation experience? He is said to learn useful and/or desirable attitudes and values vis-à-vis himself, and economic, social, and/or political systems and subsystems with which he will need to interact. These tend to build one on the other. The depth of involvement of the individual student in a game and his ability to test theories about the simulated system in which he operates and about how to manipulate it successfully may serve to:

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[6] William S. Nesbitt; "Simulation Games for the Social Studies Classroom"; The Foreign Policy Association, New York, N. Y.; 1968, p. 34.

[7] For example, see Jerome S. Bruner; "Toward a Theory of Instruction"; W. W. Norton and Co., Inc., New York, N. Y.; 1968, p. 95.

[8] Elliot Carlson; "Learning Through Games"; Public Affairs Press; 1969, pp. 158 (quote), 120.

[9] John W. Burton; "University of London: Simulation in the Teaching of International Relations"; U. C. London, London, England; 1965.

> . . . modify certain dimensions of the personality of the individual--his self-esteem, his self-confidence and feelings of efficacy, which are known to be important variables in the political behavior of the adult . . .[10]

The principal positive behavioral result is a propensity to participate in social life. Although there is a danger that overconfidence will be bred in games, most introduce an element of fortuna "to replicate the real world and teach the student that it is not completely amenable to his manipulation."[11] Even when the game world proves susceptible to student manipulation, gaming can prove to be a sobering experience similar to one undergone recently by a cadet in the POLIDOX game:

> When the game first began everyone was calm because we all knew where we stood and had decided that we'd play the negotiation game . . . .
>
> Once individual desires or goals became hemmed in by other nations' objectives negotiations went out the window . . . .
>
> The situation was very real. It allowed us to display our ineptness at functioning in a rational manner. It displayed perfectly our inability to compromise and think maturely when the pressure was on . . . .
>
> . . . I would suggest requiring all cadets to play Polidox. Why? Because it scares me to see how unprepared we are to cope with real life situations and perhaps the game can open up a lot more cadet minds to our inability to live in the 21st century as we think we are so very capable of doing.[12]

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10. Philip M. Burgess and James A. Robinson; "Political Science Games and the Problem-Solver State," Boocock and Schild; p. 247.

11. Nesbitt, p. 35.

12. David J. Palenchar; "Comments on POLIDOX"; USAF Academy, by the author; 1969, pp. 1-2.

The involvement, role identification, success, and frustration experienced in games may have beneficial effects beyond encouraging social participation. They may also serve to mitigate pre-adult disaffection from today's policy elites and the restraints and choices imposed by the social systems with which those elites must deal. Similarly, in the research area such intense involvement of identification may serve to generate an unusual number of tentative hypotheses with regard to social theory on the part of the players, which can be transferred to researchers in a properly designed critique session.

What of the impact on the participant's attitudes toward social systems? Not a great deal has been said in the gaming literature about this aspect of attitudinal socialization. What little has been reported is mostly negative. Findings in other areas of educational research, however, would tend to indicate that games, through the intimate involvement that they often foster among as well as within teams, might have a positive impact analogous to the one described here:

> . . . special types of curricula may have greater influence [on attitudinal socialization]. American students who learned about West Africans by reading only historical and geographic accounts expressed more social distance from the Africans, and a desire to maintain such distance, than did a class who read about the daily lives of the people, the problems they faced, and the help being given them through international aid bodies.[13]

Such an impact may be very different from that which one would expect through social interaction in the real world. Hence certain research ends may be less well served through this effect than socialization objectives. Much is claimed by enthusiasts for simulation games as instructional devices along another dimension. For example:

> . . . [In the past], when games and play have been accepted as appropriate for the classroom, intention has primarily been to arouse interest and to motivate the student to further study . . . . [Many] games [in use today]. . . are intended to teach, as they are, just as a chapter in a textbook or a lecture can teach.[14]

The content of what is learned does not seem so much to be specific facts, or even particular generalizations about international behavior (although there is some testimony to this type of learning in the literature from teachers and students alike).[15] This at once tends to call into question the value of historical games like Empire and to lessen the criticism of other games concerning their lack of isomorphism to reality. What simulation games do offer, at least in the field of education, according to the literature, is an excellent medium for the integration of facts and principles about social systems learned elsewhere, and above all a vehicle to aid the student in conceptualizing on a systemic level.[16] For example, "students do not simply learn _about_ the balance of power; . . . they _experience_ it.[17] If a game is _not_ isomorphic with reality, if it does not, for example, accurately represent the behavior that is characteristic of a balance of power system, if that is the intent of the simulation, all is not lost. Gamers would point out that the researcher, or the properly prepared and guided student, may learn as much or more in critiquing the game, comparing it to reality, and then engaging anew in a model-building or refining process.[18]

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[13] Richard E. Dawson and Kenneth Prewitt; "Political Socialization"; Little, Brown and Company, Boston, Massachusetts; 1969, p. 151.

[14] Boocock and Schild, p. 14.

Perhaps more important than the discovery, verification, or inculation of social facts and principles through simulation games is the development or discovery of skills or hypotheses regarding decision-making, manipulative, and interactive behavior. With regard to training uses, this relates to what was said earlier concerning the socialization of the participants in games through realistically increasing their sense of efficacy. That sense largely derives from player-perceived acquisition of new skills. Many reporters would agree that such skills are actually acquired. For example, in the case of the Carnegie Tech management game (admittedly more explicitly designed for training decision-making and implementing skills than most games):

> . . . the participants became more sophisticated about abstracting, organizing and using information from a complex and diffuse environment. Also, they became better at distinguishing between valuable and trivial information, and finally, they became more

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[15] Clark Abt; "Twentieth Century Teaching Techniques"; _The Faculty_, XXX; August, 1966, p. 2.

[16] Sarane S. Boocock and James S. Coleman; "Games with Simulated Environments for Social Studies"; Department of Social Relations, Johns Hopkins University, Baltimore, Maryland; n.d., p. 15.

[17] Nesbitt, p. 32.

[18] Western Behavioral Sciences Institute; "An Inventory of Hunches About Simulation as Education Tools"; WBSI, La Jolla, California; 1965, p. 1.

effective at coordinating information and actions between the separate functions of marketing, production and finance.[19]

If the above testimony is not too unrepresentative--E. O. Schild would say that it is not--and if Burgess and Robinson are right that the coming age will be one of the dominance of the professional decision-maker, then the learning of decision-making and implementing skills may be the most important educational outcome achieved through simulation games.[20] Similarly, the opportunity to observe the application of decision-making skills in different situational contexts may lead to the most important and valid research application of simulation games.

Whatever facts, principles, strategies, or skills may be discovered, tested, or learned in games, these occur with a higher probability of perception or retention than in the case of similar items of knowledge and insights obtained through more traditional teaching and research techniques. According to Andrew M. Scott:

> . . . the chances are that information acquired while the individual is under stress and is emotionally involved is likely to be internalized more fully than information acquired more casually.[21]

Unless a researcher is a player, however, this benefit is only indirectly obtained through the critique session mentioned earlier.

Previously, we mentioned a few tentative differentiations that can be made in the literature concerning the relation of learning and research outcomes to participant characteristics. A few observations might be made at this point with regard to variations in participant types. The needs and the levels of motivation, socialization, knowledge, and skill of both students and the practitioners differ vastly. Beyond certain limits, as yet undefined, some games would thus seem to be appropriate for one group but not for another. Simulation game enthusiasts would claim, however, that the limits are fairly broad, and that one of the truly outstanding and unique features of simulation games in education is that they "equalize or compensate for differential student status or background and experience."[22] Each student has the opportunity to order information in the particular way and at the particular level it makes sense to him. As Ronald C. Klietsch of Instructional Simulations, Inc., puts it:

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[19] Carlson, p. 43.

[20] E. O. Schild, "The Shaping of Strategies," in Boocock and Schild, pp. 143-154; Burgess and Robinson, pp. 243-249.

[21] "Simulation and National Development"; University of North Carolina, Dept. of Political Science, Chapel Hill, N. C.; 1965, p. 14.

> . . . information in simulations is not provided in any form, in any sequence until the participant is ready to do something with it.[23]

By contrast, when a teacher lectures or writes a syllabus he is saying, "This is the best way to learn this subject."

When games are used for social science research, on the other hand, some groups would be appropriate for one game or one research aim but not another, and the limits may not often be very broad. For example, advanced students and practitioners might be desirable to replicate real-world social systems, while the uninitiated, with their "unchanneled" minds, might be preferable to explore hypothetical social arrangements.

And all of this at less cost! Or at least so some enthusiasts would have us believe. Time, facilities, money, and personnel are all claimed to be required in not much larger, and in some cases smaller, amounts than is the case with traditional techniques used for teaching and research in the same substance at the same or a lower level of effectiveness.[24] But, surely, simulation games cannot be as good as all that.

Disadvantages

A careful search of the literature will produce a list of disadvantages which is, point for point, a mirror image of the list of advantages. To cite a few examples, most accounts of simulation games report that the participants were intensely interested in and motivated by the experience, but some teachers who have tried the technique report that a number of students experienced only boredom.[25] Despite assertions in the literature that the game participant is socialized to become an active participant in social processes, one may find contradictory impressions to the effect that "the danger arises that games--most of which mirror political and economic institutions as they are--may encourage quiescent and conformist attitudes."[26] Although enthusiasts stress the integration of knowledge and the systemic perspective achieved through gaming, other reporters claim that the student or researcher either is inculcated with a grievously incorrect perception of the real world system,[27] or that no systemic perspective is achieved at all: "students do not discover structural relationships in the simulate, they memorize them.[28] Some commentators would disagree with E. O. Schild's assessment of the efficacy of simulations in training participants for political decision-making:

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[22] Carlson, p. 121.

[23] Ronald G. Klietsch; "An Introduction to Learning Games and Instructional Simulations"; Instructional Simulations and Co., Newport, Minnesota; 1969.

[24] Carlson; "Description of the Program of Instruction for Use with the 'International Relations Simulation', p. 156; n.d., p. 2 and other sources.

> The competitive aspects of a . . . game . . . do arouse motivation and help sustain effort. But they may also detract from long-term learning by teaching students to play conservative strategies instead of experimenting with new approaches, to emphasize short-term profits within the game context at the expense of building and trying to achieve long-term strategic plans, and to let anxieties about relative performance and grades interfere with efforts to learn.[29]

The disparity in reports of the supposed advantages and disadvantages of simulation games cries out for explanation. Our review of the literature on gaming in the classroom and laboratory suggests three possible factors, any or all of which might provide that explanation. First, reports of educational experience with simulation games are generally unencumbered by objective data. (Researchers, attuned to the scientific method, seem less often prone to be this casual about the technique.) The principal substitute in support of claims advanced in favor of simulation games is logical deduction from theories of learning. These theories maintain, for example, that motivation is a necessary prerequisite to learning and that tangible reward or punishment enhances motivation. Those who believe in the utility of gaming reason that the rewards or punishments which games provide are more immediate and tangible than those provided the student by traditional teaching methods, and they then go on to conclude that simulation games produce greater motivation than traditional teaching techniques, and hence are better learning tools.

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[25] See Bernard C. Cohen; "Political Gaming in the Classroom," Journal of Politics, XXIV; May, 1962; pp. 371-372.

[26] Carlson, p. 173.

[27] Ibid., p. 176.

[28] Nesbitt, p. 42.

[29] James L. McKenney and William R. Dill; "The Effects of Team Assignment and Faculty Boards on Student Attitudes and Learning," in Simulation Games and Learning; ed. by Sarane S. Boocock and E. O. Schild; Sage Publications, Inc., Beverly Hills, California; 1968; p. 230.

In defense of those who rely upon deductive argument to support their claims, we should point out that empirical tests necessary to provide an objective answer are not so easy to construct as one might first believe. What is the proper test of acquired knowledge? Every teacher has struggled with that question. We are fairly confident of our ability to devise tests which measure factual knowledge, but less confident of our ability to test for knowledge of concepts or the assimilation of theoretical models, the more frequently claimed outcome of games. Employing the usual methods for testing social science knowledge thus may bias the results of a closely controlled experiment designed to measure and compare the knowledge acquired through gaming with that acquired through traditional teaching methods in favor of the latter. Is there a fair test of conceptual or theoretical knowledge? To have the student restate the definition of a concept, he has memorized may not really test his understanding of that concept in use. Yet, it is the latter which the experience of simulation games is supposed to contribute to the student's education.

In research, a related problem arises: can one ever be sure that the elements relevent to a concept or the variables acting within a system are present? Replication of a historical event or condition may be possible in a game as a check but this does not mean that all elements or variables acting to produce that event or condition in the real-world are present.

Some empirical studies have been attempted in educational applications, most treating simulation at the secondary school level. For the most part, these tests have concluded that no significant differences exist between the knowledge acquired by the control group subjected to traditional teaching methods and the knowledge acquired by the group exposed to a simulation game.[30] Still, one should be cautious in interpreting these results. Perhaps the "no difference" findings were the result of an inappropriate test of the kind described above.

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[30] See Nesbitt, pp. 41-42 and Carlson, pp. 171-172.

If new empirical studies have been accomplished, how do advocates of gaming justify their position, other than, in the case of educational uses, by deduction from learning theory? The usual justification takes the form of a subjective evaluation. In education, teachers incorporate a game in their course and observe the game's effect upon the students. This type of appraisal generally is accomplished in conjunction with an end-of-course questionnaire administered to students in order to discover their subjective judgement of the gaming experience. The teacher then concludes that the "experiment" with simulation was a success (or a failure) and cites appropriate "typical" commentary from the questionnaire as evidence. Researchers who have used games and reported favorably on the results usually have experimented with the method in conjunction with other techniques. Perhaps in so doing they have attempted to guide the course of events in the game to correspond with the results derived elsewhere, and have concluded that games "added significantly," but usually no more than heuristically, with their usual research task. This method of evaluating the utility of simulation games leads us to a second explanation for the confused picture presented by the literature on gaming in the classroom and the laboratory.

Reports of the actual use of simulation games tend to fall into one of two categories--very favorable reaction or very unfavorable reaction. In terms of quantity, most accounts fall on the favorable side of the ledger. Bernard C. Cohen has suggested a reason for this. He asks if possibly those who direct games and conclude that the experience was worthwhile might have approached their evaluation with a preconceived bias in favor of simulation. Lacking objective criteria, such individuals may see in the simulation only "the evidence which confirms their wisdom in conducting the exercise."[31] A favorable predisposition toward gaming may bias not only reports of results but the results themselves. The effect of games in the hands of the enthusiast may be impressive, but the average teacher may not be able to produce the same kind of results. Similar reasoning might explain the reports of unfavorable experiences. If the experimenter begins his evaluation skeptical of the value of simulation games, his bias might both adversely affect his conduct of the games and color his subjective judgment of results.

If the above chain of reasoning is sound, the subjective nature of most evaluations of the utility of games coupled with the tendencies to effect learning and research outcomes in the manner of a self-confirming hypothesis and then to read the evidence through the tinted spectacles of preconceived bias provides the second factor which might explain the conflicting reports of classroom simulations.

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31. Cohen, p. 371.

There is still a third explanation. Most teachers and researchers who have experimented with the simulation technique have had direct, personal experience with only one, or at most two or three, different types of games; yet the scope of their conclusions generally claim or imply application to all games. Different games, however, may have different learning or research outcomes. In fact, we suspect that this would make a better initial assumption than the opposite, that all simulation games no matter what their structure have the same influence upon outcomes.

Having criticized others for asserting conclusions about the relative worth of gaming on the basis of inadequate empirical data, we shall now proceed to make the same error. Simulation has been done at the Academy for over five years. We have not yet used games in any systematic research effort, nor have we made a systematic investigation of the teaching value of the games we play. We have only personal, subjective judgments to offer about the utility of games, judgments of our students as well as ourselves.

Our experience suggests that simulation games suffer from three serious weaknesses. First is the lack of control which the teacher has over what is learned during the game or the instructor would have over certain kinds of variables worth investigating. In education, we are satisfied that the majority of players learn the "right" lessons from the game, the lessons we intended them to learn. But now and then we discover a student who has learned the "wrong" lessons. Traditional teaching methods include making certain that students learn the "right" lessons by telling them explicitly what the "right" lessons are. While simulation games are supposed to be a superior teaching technique in that the "right" lessons are discovered by the student himself through a process of trial and error in the simulated world, at times the simulated world, like Frankenstein's monster, develops a will of its own, takes off in a direction unintended by its author, and begins to spew forth all sorts of "wrong" lessons. When this occurs the teacher has a difficult time "correcting" the learning experience of the student. After all, if it is true that living through the experience of a simulated world plants a lesson more firmly in the minds of a student than does reading about that experience, then it is true that "wrong" lessons may be planted equally deep during the play of a game. In research, needless to say, it is even more difficult to correct the "wrong" lessons than in teaching, in that one is less certain what the "right" lessons are. Overly controlling to ensure the "right" lessons may simply be an exercise of insuring self-confirming hypotheses.

The second disadvantage we have encountered is the problem of arranging student or subject schedules, class or subject group size, and the physical setting required for a game. To those who extol the virtues of gaming these are minor problems. They claim that "simulations do not require the use of facilities or equipment beyond what is present in almost every school or what can borrowed or fabricated by resourceful students and teachers."[32] For others, "simulation can be a complicated procedure requiring space and equipment."[33] We stand with the latter group.

It is true that if students and teachers are sufficiently motivated to try a simulation, the necessary time to conduct play can be found on weekends and evenings if schedules will not permit play during regular class hours. It is also true that imagination and ingenuity can go a long way in adapting existing physical facilities to what is required in order to play a particular game. Nevertheless, these matters take considerable time to arrange and must be counted as a liability in using the simulation technique. Furthermore, we should like to stress that physical arrangements are seldom if ever neutral in their effect upon the game. Whatever physical arrangements are chosen introduce a kind of artificial geography into the structure of the game which the experiences of others as well as ourselves have shown bear important consequences.[34]

The third disadvantage of simulation games is the cost of gaming in terms of the teacher's or researcher's (and sometimes the student's) time. Here again there is disagreement. Some who experimented with the technique conclude that "larger numbers of students can be taught effectively with no increase in staff."[35] We disagree. Our experience with games has been that it is quite expensive in terms of the individual supervisor's time and in terms of the supervisor-participant ratio which games require. During the play of the game, the supervisor must monitor events, make on-the-spot rulings unanticipated in the design of the game, and otherwise act as a judge and final authority as to how the game rules are to be interpreted and applied. As mentioned previously, it takes time to make the necessary physical arrangements. Between periods of play the game supervisor is often engaged in performing numerous calculations of results.

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32. Hall T. Sprague; "Using Simulation to Teach International Relations"; WBSI, La Jolla, California; n.d., p. 114.

33. Burton, p. 4.

34. For example, see Cohen, pp. 377-378.

35. Burton, p. 4.

Of course some games are more demanding of the teacher's or researcher's time than others. A carefully constructed game which has been refined and "debugged" by way of several replications might be handled with ease by one person. Computers can reduce the time necessary to keep books and make computations, but may result in trading one type of cost for another.

Conclusions

It would be presumptuous to advance conclusive propositions on the basis of this working paper. We have no firm conclusions to state at this time. We have only vague hunches about the value of simulation games in teaching and research, and our hunches tell us that something of value is there. Final answers must await the empirical research in which we ourselves are engaged which would encourage others to undertake.

Our present research efforts include the development of a questionnaire to be distributed to those members of the academic community, government agencies, and private research organization we can identify as having had experience with simulation games in the social sciences. This questionnaire will provide survey data which will be used to refine a descriptive typology of simulation games, their applications, their circumstances of use, and their users. By means of this questionnaire we also intend to survey gamers concerning their subjective and, where possible, objective assessment of both the absolute and relative advantages and disadvantages of the gaming technique.

We seek more than description. We plan to use the data garnered from the survey effort to relate the descriptive characteristics mentioned above to learning and research outcome experienced by the respondents, which we will take to be a representative sample of the gaming universe. Our ultimate aim is to identify independent and dependent variables relating to the use of simulation games, to infer causality, and to establish norms for game use based on the inferences that we derive. In particular, we hope to be able to point out the opportunity costs and benefits of the use of simulation games in areas of social science teaching and research already at least adequately dealt with by other techniques and to identify absolute costs and benefits in areas in which no other adequate tools exist.

Why do we set this task for ourselves? First, we are subjectively convinced of the value of gaming from our own experience here at the Academy. Second, even if we were convinced by the arguments of the skeptics and the debunkers, which, to some extent, we have been, we might still feel the present effort was worthwhile. As one disappointed experimenter with simulation games wrote seven years ago:

> . . . an enterprise which requires such a heavy investment of time, effort, and resources as this does, ought to have a predictably high return. It would be hard to claim that such a point has been reached at the present time, although one can go a step further and argue that *it will never reach such a point unless there is further 'experimentation' with, or, more properly, development of, the technique*. (italics added)[36]

All the votes have not been cast on the question of whether or not simulation is worth it all. We hope to make the ballot box available. While there may be only a small chance that simulation games will eventually provide the breakthrough they promise, we are convinced that the potential returns make it worthwhile to take that risk.

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[36] Cohen; p. 380.

"LEARNING GAMES IN THE DePAUL COLLEGE"

Nancy Klein
DePaul University

DE PAUL SIMULATES!

Nancy H. Klein
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The directives were clear. Within the University, De Paul College was being formed, carrying out the Vincentian corollary: Man's true personal being is fulfilled in community, by becoming involved in mutually humanizing relations of man with man.[1] Fall of 1967 saw the first of the new courses in the four divisions: Humanities, Philosophy-Religion, Behavioral Social Sciences and Natural Sciences.[2] A student who could not only conceptualize but would "develop abilities in perception" was a goal. "As curricular design takes direct cognizance of the 'climate' in which learning takes place...the situations of learning shall provide for a lively interaction..."[3] It was time to look around for the best way to present our Behavioral Social Science course, Man and His Community, with a final bit of support from the Curricular Design: "Tensions and strains will arise requiring faculty patience in the art of guiding students through unstructured situations rather than through highly structured classroom instructional methods and practices."[4] A clarion call for simulation it did seem.

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1. "A Curricular Design for De Paul University"; unpublished; p. 3.

2. Credit is hereby given to the Dean of De Paul College, Dr. Martin J. Lowery, and the Divisional Head of the Behavioral Social Sciences, Dr. William R. Waters, for their continuing support and encouragement.

3. "A Curricular Design for De Paul University"; unpublished; p. 26.

4. Ibid.; p. 31.

After experimenting with such approaches as "Impact"[5] and "Simsoc"[6] a format for the course has evolved which combines a board game called "Ghetto"[7] played at the beginning and the end of the course and simulation of the Lincoln Park Community for the major content. This is the area surrounding the University and into which it is expanding with all the clamor currently attendant upon institutional growth. Some students are quite involved in community activity, others are totally unaware. Rather than emphasize these differences, however, we focus upon the interests each student has and assume he will want to know more about them. For example, a future school teacher will benefit from observing local schools, someone interested in politics has an opportunity to interview the alderman in each ward and there is always someone curious about local gangs---now called youth groups.

A great deal of time is spent at the beginning of the course encouraging students to discuss their special interests. As we attempt to round out the major roles in the community, it is important that these roles be assigned on a voluntary basis in order to maximize motivation. The one role not simulating a real person in the community is that of the editor of the class paper. His job is to organize the research results brought in by the class and communicate the information in a weekly paper. Each class develops their own identity through their paper, called something like "The Lincoln Blabber" which includes humor and editorial comments along with the information. Students are told to interview, observe, participate, and devise any technique they can think of to understand their particular segment. They go into the community singly or in small groups, attend meetings, arrange their own interviews, devise research instruments, write up results and tell the class about it. It is important to have the class share early knowledge so that an awareness of the situation in the community grows in each student. Whenever a student finds a respondent who vividly portrays his area of research he invites him to class in order to bring a three dimensional type of knowledge to the topic. Last quarter an erudite car-hiker, working in a Lake Shore Drive hi-rise, came to class and regaled us with his world view. He was discovered by a student researching the rich.

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5. A 3-M Product, now discontinued.

6. William A, Gamson; Simsoc; The Free Press, New York, New York; 1969.

7. Produced by Urbandyne Corporation; Chicago, Illinois; 1969.

The class meets once a week during the initial stage in order to give primary importance to the field research. By the fourth week a current community issue is selected, not for a full scale simulation, but for a simple role-playing situation. This quarter, for example, a housing proposal drawn up by an architect for the Poor People's Coalition was turned down by the Department of Urban Renewal after being recommended by the Conservation Community Council. It was an unprecented move and many parts of the community were aroused. Instead of simulating this volatile and complex situation so early in the class development we played out a situation where all the girls in the class were homeowners and all the boys were members of the Poor People's Coalition. The next class session we reversed these roles. It was interesting to note how the first hurling of a stereotype such as "Why should you have decent housing anyway---you'll only mess it up" was enough to stop any communication and reduce the interaction to name-calling. This sample was enough for "getting the feel" and providing some good discussion such as how easy it was for a student who thought he was a radical to get into the role of a possession-preserving, mistrusting defender of the status quo. And what fun for a conservative middle-class student to try his hand at some rhetoric-hurling tactics of the Poor People's Coalition. It should be noted here that it is not the "fun" that makes the student learn; it is the group atmosphere inducing high enjoyment and high individual learning.[8]

Now they were ready, while the interest was high. The class discussed situations that would bring in the whole community, that had either actually taken place or might be expected to take place. One simulation we did involved the Young Lords, a local Puerto-Rican youth group and their takeover of land cleared by the Department of Urban Renewal. When word came out that only tennis clubs had bid for the land the Lords claimed it for a "People's Park". Each member of the class wore a tag signifying his role in the community and the action began. After the initial muddle, leaders developed and goals were stumbled upon. Would the homeowners oppose the park? What role would the police play? As the advantage fell to those who had thought things through and the schemes grew there was the excitement generated by feeling the power inherent in your area or the frustration at the lack of it. And there was the compensatory outlet of being able to kick and scream when denied access to

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8. See Michael Inbar; "Individual and Group Effect on Enjoyment and Learning in a Game Simulating a Community Disaster"; in Sarane S. Boocock and E. O. Schild (eds.); Simulation Games in Learning; Sage Publications, Beverly Hills, California; 1968.

traditional means of goal realization. How did realtors feel about the situation? And the category "neighborhood kids" for whom the park was being developed? Would their parents let them go there when rumor had it there was going to be violence? Each student was asked to simulate reality and play it out exactly as he, on the basis of his research, considered his part of the community would generally react. He was to play a kind of consolidation of all of his information. He was assured that he would be given an opportunity to try out his personally innovative ideas at a later time, but the purpose here was to understand what can really happen and why. This time a fiesta drew support from all but the most conservative elements; the police were in evidence but not active and the local officials declined to retrieve the land, at least for the moment.

The most informative time is the discussion after the action has been terminated. Here the instructor must decide when fruitful activity has moved into a repetitious pattern, or how far he can let the violence go, or when to simply end a stalemate.

As the course progresses through a series of simulations growing from class suggestions and building upon earlier situation, students come to see what actions are effective and what political, social, and economic obstacles block their way. The major goal sought with the simulation approach is in developing student decision-makers better equipped to handle the complexities of real life situations. How more perceptive and equipped to participate as adults in their communities they become, it is, of course, impossible to predict. We do see a measurable difference in the decision-making that takes place in the "Ghetto" game at the beginning of the course and at the end when the simulation experience is over.[9] Students do see that

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9. A recent example had the white group (a fourth of the population) develop a prearranged plan of evacuating the city and founding a commune on the outer suburban reaches. This had the effect on relieving density problems and providing space for a city of parks and schools and single story dwellings along with employment for all. But the mayor declared the commune outside his jurisdiction and cut off all services. The white group's utopia thus became virtually a ghetto. Soon the members of the wealthy group took pity on the whites and set up a meeting to discuss methods of integration with the commune dwellers. While they were at the meeting city authorities moved the commune back into the city. Rather than appreciate what had been done for them, the commune group muttered something about "doing it to us, not with us" and burned down the city.

the decision-making dimension of the social system is dependent upon their values. They do get experience with other value systems. And they learn about themselves.

Within the context of the simulation printed resources as well as human resources become useful tools. Books on political influence, zoning regulations, neighborhood groups' information may all prove useful in implementing a plan for group survival or individual mastery. This is a very different kind of reading from that done in order to pass a test on the subject matter. The active learning during the course often leads to community involvement continuing beyond the course itself. And when the president of a neighborhood group requested a meeting "to correct errors" appearing in our class paper, it made us consider the spin-off effect of being observed, on local decision-makers. The final result that should be mentioned is the fact that whereas these students who thought they knew a great deal about the community learned about other elements in the community; those who knew or cared little of it became aware in a way that was surprising to them.[10]

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9. (cont.) This is described as an example of creativity more than maturity; however, every participant learned how much easier it was to solve problems such as housing and employment with an administration committed to a good life for all, plus a sharply reduced density. They were genuinely surprised when the white group did not trust the actions of the other groups who were working together so well.

10. Statements such as: "No longer can I walk from the 'el' to school with blinders on"; "I don't want to be on the outside anymore, I want to be involved"; "I don't know how it happened, but I don't stereotype people the way I used to"; "Understanding the complexity more let's me see where I can fit into this exciting and depressing community"; and "I have come to the conclusion that my energies will go to support action groups, operating outside the existing 'establishment'" indicate that the political range is wide, but now they all have a feeling for who they are in terms of the community.

During all this the instructor's task is one of implementing and integrating the action for the participants. He must be neutral. We can still remember the outrage of a group when the instructor allowed himself to be drawn into a supporting position for a plan by the antagonists of this group. He must also motivate the group initially until they get to the point where the students themselves can see that those putting more in are the ones having a good time in the course. When this happens early enough those with a tendency to withdraw can experiment with changing their behavior. This is one of the benefits of a game situation: one can risk loosing and try something else. Here is where a little encouragement and support from the instructor can be useful. And he can help the participants see the beauty of a well-managed conflict.

Simulations are not laboratory experiments and what happens in terms of activity and outcome cannot be predicted. That students have learned, particularly in the area of decision-making, is supported in the way the simulation and game variables are handled and in the discussion that follows. Our assumption is that there is nothing as fascinating as reality. The better the simulation, in this sense, the more intense the learning experience. Therein lies the challenge and the reward.

"SIMULATION IN BEHAVIORAL RESEARCH AND TRAINING IN THE FIELD OF SPECIAL EDUCATION ADMINISTRATION"

Daniel D. Sage
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SIMULATION IN BEHAVIORAL RESEARCH AND TRAINING IN THE FIELD OF SPECIAL EDUCATION ADMINISTRATION

Daniel D. Sage
Assistant Professor of Special Education

The problem of definition of terms, when one attempts to communicate to the field regarding simulation, is a particularly difficult one. It appears that the word simulation is most often used in a generic sense, to include a wide variety of approaches and materials. Dawson, in classifying simulators according to physical characteristics includes pure machine simulators, man-machine simulators, man-to-man competitive gaming, real-time simulators, and Monte Carlo Methods. He further points out that "simulation, for the social scientist, is the building of an operating model of an individual or group process and experimenting on this replication by manipulating its variables and their interrelationships."[1]

The word gaming is more likely to be used to identify a specific type of simulation in which there is competition between a player and another player, a machine, or other materials, in which a definite set of rules determines the interaction and a definite win or loss is noted.

However, there is evidence of considerable confusion and ambiguity regarding such terminology as interest in the whole field rapidly increases. This was particularly evident at the annual meeting of the American Educational Research Association (March 1970) where it was noted that the Special Interest Group on Simulation had grown over the past three years to such size that two separate symposia were scheduled to accommodate the papers submitted and the audience interest. The variety of content in the research and development activities reported at these symposia made apparent the need for some agreement regarding definition, and perhaps a published glossary so that those in the field of education who claimed interest and activity in simulation and gaming could communicate with greater clarity.

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1. Richard E. Dawson; "Simulation in the Social Sciences"; Prentice-Hall, Inc., Englewood Cliffs, New Jersey; 1962.

It is the purpose of this paper to report on activity in the field of educational administration and to report particularly on the area of special education administration, that aspect of educational administration concerned with programming for handicapped children. In terms of this reporter's perception, the major work being done in the field of educational administration, has been limited to materials and approaches that are non-game simulations and involve role-playing within a simulated environment. One exception is "The Negotiations Game"[2] in which participants are assigned to teams, role playing either school board members or teachers organization members in a collective bargaining exercise. In this simulation, the competitive element essential to gaming is present and a win-lose conclusion results.

The major simulation effort in educational administration has been the "Whitman Elementary School" package[3] which was developed under a Cooperative Research Grant beginning in 1958 and focused upon behavioral research and training for the role of the elementary school principal. The apparent success and the obvious popularity of the method and materials growing out of that endeavor led to the dissemination of the material and the training of professors in its use, by the University Council for Educational Administration, an agency serving some 60 member universities conducting training programs in educational administration. The package consisted of a simulated school, school district, town and state, with written and audio-visual materials providing abundant background data through which persons playing the role of the school principal could be quite well informed regarding their new position, and could, therefore, make decisions on the problems presented through the mode of the written communication in-basket. Supplemental input in the form of audio taped conversations were provided, but interactive aspects were limited to a few group problem solving exercises and all participant responses were limited to the written mode, e.g., memos, rough drafts of letters, notes for speeches, lists of things to do, etc. While the use of the material called for discussion sessions in which participants could compare approaches and decision choices after the fact, there was no provision for immediate feedback or chaining of a series of inputs and responses.

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2. John J. Horvat; "Professional Negotiations in Education: A Bargaining Game With Supplementary Materials"; Charles E. Merrill Publishing Co., Columbus, Ohio; 1968.

3. John K. Hemphill, Daniel Griffiths and Norman Fredericksen; "Administrative Performance and Personality"; Teachers College, Columbia University, New York; 1962.

Over the past years (1966-69) the University Council for Educational Administration, through a number of task groups, has carried out a revision of the original materials and an expansion to include such roles as the Superintendent, Business Manager, High School Principal, all based on the same prototype system updated and now named the Madison School District. The incorporation of the role of Director of Special Education in this School System is now being carried out on a sub-contract at University of Pittsburgh by Godfrey Stevens[4].

In the intervening years during which the University Council for Educational Administration materials were being revised, another development specifically focusing on the role of the local school district administrator of special education was generated in the form of the Special Education Administration Task Simulation (SEATS) Game.[5] This material, which is not a game by the criteria mentioned earlier, was developed as a response to a demand for a pre-internship personnel training vehicle which could also serve as a standard environment and experience within which administrative behavior could be studied. This material was developed from scratch, since the geographic, political, and demographic particulars of previously existing simulated environments did not, in the opinion of the author, lend themselves to optimal involvement with the problems and issues in administration of programs for the handicapped that were felt to be needed.

While the SEATS materials also depend to a large extent on the written communication in-basket, a number of additional inputs are provided. One mode involves telephone call interaction in which problem situations are posed by an assistant instructor, following an open-ended script, and in which various alternative actions taken by the student are responded to by the instructor for the purpose of realistically demonstrating to the student the variety of ways he can be trapped out on a limb by an unpleasant adversary. Other variety of input involves role playing the supervisor-teacher evaluative conference which follows a filmed observation of the teacher's classroom performance, or role playing the case conference committee process in which decisions must be reached regarding child placement, or other long range planning and goal setting conferences. The use of audio and video tape playback of oral communication performance provides feedback capability which appears to have considerable instructive value. The realism factor, according to testimony of participants, is a key determinant in both the cognitive and affective impact of the package.

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[4] Godfrey D. Stevens and Lawrence P. O'Neill; "An Application of Simulation Training for Special Education Administrators"; Paper presented at National Conference on Special Education Administration, Austin, Texas; 1969.

[5] Daniel D. Sage; "The Development of Simulation Materials for Research and Training in Administration of Special Education"; Final Report, USOE/BEH, Syracuse; 1967.

The SEATS has now been used by its author in a variety of settings; intensive 3-day workshops (6 times), intensive 10-day institutes (3 times), and conventional semester courses (3 times). The optimum schedule appears to be the 10-day institute and the most feasible group enrollment is about 20 participants. Kits have been disseminated to over twenty other university training programs where they are in use by professors who had attended a three-day training-in-use institute before being permitted to purchase the materials.

At this point, experience with the material has suggested areas which could well be modified, or deleted and a number of new additions which would be expected to improve the package as soon as a revised edition can be prepared.

Two additional projects now under way are direct outgrowths of the SEATS. The first of these developed from the recognition that in the field of special education, as is common to many areas, we often spend time preaching to those who are already disciples when we might better be investing our time in missionary work with the infidel. In this regard, a project was proposed in which the SEATS would be used as a vehicle to sensitize general school administrators, who ordinarily are able to ignore certain problems because they belong to the specialists, to the critical issues in programming for the handicapped. The method involves inducing this target group to assume an unfamiliar role and by "walking in the other fellow's mocassins" to become more keenly aware of matters needing attention in his regular role. A pilot project, which will be reported elsewhere[6] showed sufficient promise that a more extensive research effort is now under way involving assessment of attitude change on the part of school principals as a function of such an experience.

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[6] Philip J. Burke and Daniel D. Sage; "The Unorthodox Use of a Simulation Instrument", Simulation and Games; scheduled for publication, September 1970.

Another concurrent project is concerned with the development of an entirely new package focusing on the role of the State Education Agency Administrator of Special Education, as opposed to the local administrator. Under a grant from the Bureau for Education of the Handicapped, U. S. Office of Education[7], this development is utilizing a method of studying the activities of encumbents in such positions from over 30 states, as a means of providing reality based materials for the simulator, which will follow approximately the model of the SEATS, but will make use of more video-taped input, more group problem solving situations, and long range future planning tasks. The prototype will be piloted in a 10-day institute in June 1970 in which a neophyte State Agency employee from each of 25 states will be invited to participate. An evaluation of the effectiveness of the materials and approach will focus on dimensions of information processing, sensitivity to issues, and organization for planning as these factors relate to problem solving.

The greatest need, which is now beginning to be met, is controlled research on the treatment effects in terms of behavior change, of various simulation materials and activities on relevant target groups.

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7. Daniel D. Sage and Edward W. Sontag; "The Development and Evaluation of Reality-Based Simulation Materials for the Training of Special Education Administrators in State Departments of Education"; Special Project Grant Award OEG-0-70-1290(603), USOE/BEH; 1969.

GAMING DEMONSTRATIONS

"BRIDGE PLAYING GAME"

Winston Riley III
Riley Systems,
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Research Analysis Corporation

AN INTERACTIVE BRIDGE PLAYING PROGRAM

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McLean, Virginia

ABSTRACT

This program demonstration is an interactive bridge playing program which is operational in a time-sharing environment. The program plays the declarer and dummy cards while interacting with human opponents playing the cards of the defenders. The exact defensive holdings are not known to the program except as established during play.

The program addresses the full range of problems confronting the declarer of a bridge deal. For instance, the program considers winners to be developed, losers to be disposed of, finessing patterns, transportation between declarer's hand and dummy, hold-up plays, unblocking plays, and certain advanced plays for end situations.

The program performs both strategical and tactical analysis during the play of a deal. The strategical analysis is performed at the beginning of play and also after each trick is over. The tactical analysis is performed at both this time and before playing a specific card from the declarer or dummy hand.

The program is operational in a time-sharing environment on a Burroughs B-5500 computer. It operates in a conversational mode which allows the on-line interaction between the computer program and the human defensive players. The program is in a state of rapid development and, thus, while it plays a respectable game, it is too early to evaluate the near term level of intelligence to be attained.

BRIDGE DEMONSTRATION

A live competition between a computer and human opponents will be held on Sunday afternoon from 1:00 p.m. to 3:00 p.m. in the Brittany Room. The Riley-Throop Bridge-Playing Program will be demonstrated by its authors against pairs of selected attendees. Real-time play will be achieved by means of a remote terminal to a time-shared computer.

Several bridge hands will be dealt, a declarer and contract established, and the deal then played. The computer will either act as declarer, playing the declarer and dummy cards, or will act as each defender, playing each defender's cards independently. The play of the deal will be displayed for the attendees to follow.

After actual play, a critical analysis will be given of the program's performance in a few of the deals, followed by a general open discussion.

"BUILD – A COMMUNITY DEVELOPMENT SIMULATION GAME"

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"BUILD" -- A Community Development Simulation Game

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ABSTRACT

"BUILD" is a role playing computer game designed to assist in advocacy planning of new communities within the city. The model is designed to represent the typical situation of extreme deterioration of housing, services, and economic activity in an urban area designated for rapid physical transformation, but with a major emphasis on preservation of community values. BUILD is intended to provide a mechanism for members of the community to actively participate in the decision making process, and as an educational tool.

The structure is relatively simple with roles divided into the three broad classes of business, government, and people (residents). A demonstration via time-sharing terminal will be presented.

"CZECHOSLOVAKIA 1968: A SIMULATION"

John P. McAbee
Boston University

CZECHOSLOVAKIA 1968: A SIMULATION

John P. McAbee
Boston University

This paper is an attempt to describe one particular function of games at Boston University, that is for educational purposes. Simulations at Boston University have been used as operating models of historical situations to further students' knowledge in International Relations. It should be emphasized that these simulations are not useful in policy-making or research applications. They are used solely to acquaint students with historical facts and International Relations concepts. Primarily the International Relations simulation exercise has concentrated on central and Eastern Europe in terms of power dynamics rather than strictly in terms of Soviet Foreign Policy. The Czechoslovakia 1968 experience exhibits the primary factors needed for an introductory International Relations game; (1) A small country linked ideologically, economically, militarily, and geographically to a super-power; (2) It has undergone dynamic change in contemporary times vis-a-vis membership of super structure and economic, political, and social development; (3) The changes described have altered the conditions of a previous long-standing relationship to the super-power and other nations of the Bloc. It is obvious from the foregoing that this type of situation is essential for an understanding of modern day International Relations. The bases of power of the modern world have placed increasing stress on the role of small aligned and non-aligned nations. This is especially important in the case of the East European Communist countries. It is for the above reasons, along with its current importance, that Czechoslovakia 1968 was chosen for one of the initial simulations.

The purpose of International Relations simulations at Boston University is three fold; these goals are, to challenge the student, to stimulate him to further research, and most importantly to facilitate further learning.

The student is challenged because of his direct involvement in the situation that is being played. He is not only a role-player but due to his participation he becomes a character himself. He finds he must deal with real people and real facts.

The student is motivated to research before, during, and after the simulation. The scenarios are given to the student a week in advance of the actual game and the student is assigned a role at this time. The student is required to be familiar with his character, the chronology, and the general situation in Czechoslovakia. Additional readings are readily accessible to the participants. During the simulation the students become aware of, and interact with, the other characters. Specific problems of the exercise of power confront the actors and hold them with a sense of crisis.

After the simulation the student is encouraged to do further research on his own as a result of the intellectual stimulation provided by the game. It has been found that he desires to learn more in-depth material concerning the crisis, his particular character, and the other characters. It is also possible that he may develop an interest in related areas such as Soviet Foreign Policy, the Warsaw Pact, East European studies, or the Balance of Power.

The medium of simulations promotes a natural learning process. The student's curiosity is immediately aroused by the presentation of the scenario, since the basic International Relations course at Boston University is given at the sophomore level and most students have had no prior experience with this tool. The player is required to assimilate his role into the chronology and determine his policy which he must immediately use to interact with other policies and players. During the simulation the student begins to grasp basic International Relations concepts and use them with his role-playing. After the game the learning process continues through a post-game evaluation and contact with current published articles. This simulation method provides the learning incentive to bridge the gap from classroom to dorm room and many students have commented on the viability of filling the gap.

Perhaps the most unique feature of this simulation is that it can be played in ninety minutes. This is in contrast to other well known simulations which require weeks or even months to complete. There are several factors which contribute to this compactness. In our situation they are generally due to advance preparation. Specifically, the students prepare ahead of time, the simulation is distributed in advance, and the participants are aware of their parts. Additionally, the chronology is edited to emphasize dynamic and key points while facts unnecessary to the crisis are relegated to lesser importance. Through a series of steps, pressure is built up quickly and the simulation opens with participants stimulated to action. The all verbal aspect of the game allows for a much quicker stimulus-response conditioning.

Also our method eliminates the need for any elaborate materials. The game can be played utilizing only the mimeographed scenario and character sketches. There is no need for printed forms, flow charts, or an intricate set of assumptions as is common in many other games. Complex gaming facilities are not required as the simulation benefits from being played in one room.

The game scenario itself is divided into several sections. The first of these being the teams. The participants are actually involved in only one team i.e., Czechoslovakia, with Control playing the Soviet Union and other Warsaw Pact countries. Roles of the Czechoslovakia team are carefully chosen to give not only full leadership representation but a balanced ideological outlook as well. In Czechoslovakia 1968 representing a Liberal-reformist attitude are Alexander Dubcek, Josef Smrykovsky, and Oldrich Chernik. Ideologically counter to this is a group of conservatives composed of Alois Indra, Vasil Bilak, and Drahomir Kolder. To introduce a moderate viewpoint to the simulation Ludwig Svoboda and Gustav Husak are used.

The advantage of having Control playing the other teams is that it allows a stricter regulation of the game. Control has the ability to change the crisis by additional inputs and to therefore move the simulation through lapses of action. Also, Control is able to manipulate the actors in such a way that they stay within the historical context.

The chronology begins with a brief historical survey of the 1950's to the Autumn of 1967. Then, beginning with the end of October 1967, the chronology builds the significant facts into a cohesive document ending with June 1968. The participant, through the chronology, grasps the overall significance of events during the crisis in Czechoslovakia. Documentation supports events in the chronology as needed, providing maximum utility in a minimal amount of time.

The move periods were selected on the basis of historical significance, relevance to the overall crisis and their importance to the overall approach to International Relations with regard for their ability to provoke or stimulate the student. In Czechoslovakia 1968 there are three move periods: (1) July 15 - July 17, 1968, with the focus of attention on a) the presence of 18,000 Warsaw Pact troops in Czechoslovakia and b) the Warsaw Letter; (2) Cierna Conference of July 29 - August 1, 1968; and (3) Presidium meeting of August 20, 1968. It should be emphasized that the success of an educational simulation is directly proportional to the stimulative ability of the move periods. In the Czechoslovakia 1968 experience, these move periods have satisfied all our requirements.

PROGRAM
OF
EVENTS

STEERING COMMITTEE

PETER HOUSE, CHAIRMAN
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THEODORE J. WANG
AMERICAN UNIVERSITY INSTITUTE FOR CREATIVE STUDIES

ASSOCIATES

GINA IZBIKY
ENVIROMETRICS, INC.

GORDON SMITH
GEOMET, INCORPORATED

PROGRAM

FRIDAY

3:30 P.M. - 6:00 P.M.
REGISTRATION* AND CHECK-IN

*THE SYMPOSIUM REGISTRATION BOOTH IN THE LOBBY WILL BE OPEN EACH DAY TO SERVE AS A MESSAGE CENTER AND TO REGISTER PEOPLE WISHING TO ATTEND INDIVIDUAL DAYS OR SESSIONS OF THE SYMPOSIUM.

SATURDAY MORNING SESSION
(BRITTANY ROOM)

9:30 A.M. - 11:30 A.M.

OPENING
PETER HOUSE, SESSION CHAIRMAN

1. "META MODELING AND WAR GAMES"
   GEORGE ARMSTRONG
   USA STRATEGY & TACTICS ANALYSIS GROUPS
2. "GENERALITY IN A MAN-COMPUTER GAMING MODEL"
   RICHARD F. BARTON
   TEXAS TECH UNIVERSITY
3. "TEACHING ECONOMICS WITH COMPETITIVE GAMES"
   MARTIN SHUBIK
   YALE UNIVERSITY

SATURDAY AFTERNOON SESSIONS
(BRITTANY ROOM)

1:00 P.M. - 3:00 P.M.

SESSION A - BUSINESS GAMES
THEODORE J. WANG, SESSION CHAIRMAN

TOPIC QUESTION: "CAN WE DESIGN BUSINESS GAMES THAT DEVELOP INNOVATIVE BASIC BUSINESS POLICIES?"

1. "A FINANCIAL MODEL FOR A COMMERCIAL BANK"
   ROBERT P. BEALS
   TEXAS A & M UNIVERSITY
2. "AN ECONOMIC STRATEGY ANALYSIS GAME"
   JAMES A. ZWERNEMAN
   RESEARCH TRIANGLE INSTITUTE

SESSION B - SOCIAL SCIENCE GAMING
JAMES COLEMAN, SESSION CHAIRMAN

TOPIC QUESTION: "ABSTRACTION VERSUS REALISM IN SIMULATION GAMES"

1. "A SOCIAL SIMULATION STRATEGY FOR RESEARCHING THE ISRAELI-ARAB CONFLICT"
   JOSEPH D. BEN-DAK
   UNIVERSITY OF MICHIGAN

2. "Low-level Gaming in a Community Emergency Operations Systems Development Context"
   CHARLES J. DAVIS
   OFFICE OF CIVIL DEFENSE
   DEPARTMENT OF THE ARMY

3. "The Use of Simulation Games in Instruction"
   JERRY H. FLETCHER
   JOHN ADAMS HIGH SCHOOL

4. "Simulation in High School Geography"
   ANGUS M. GUNN
   UNIVERSITY OF BRITISH COLUMBIA

5. "The Carolina Population Center Family Planning Policy Game"
   THOMAS H. NAYLOR, ARNOLD H. PACKER AND R. SCOTT MORELAND
   UNIVERSITY OF WISCONSIN

6. "Economics of the Environment Decision Model: A First Step"
   JAMES J. SULLIVAN
   UNIVERSITY OF CALIFORNIA, SANTA BARBARA

(BRITTANY ROOM)

3:15 P.M. - 5:00 P.M.

SESSION C - MILITARY MODELING

JET LEWIS, SESSION CHAIRMAN

TOPIC QUESTION: "WHAT IS THE FUTURE OF MILITARY GAMING IN 1975-80?"

1. "Courses and Master Theses Related to Simulation in the Operations Research Curriculum at the Naval Postgraduate School"
   ALVIN F. ANDRUS
   NAVAL POSTGRADUATE SCHOOL

2. "Sea Warfare Integrated Model (SWIM)"
   L.F. BESIO
   JOINT WAR GAMES AGENCY
   OFFICE OF JOINT CHIEFS OF STAFF

3. "A Computer-Assisted Game for the Evaluation of Air Defenses in a Combat Environment"
   JOSEPH BODO
   SYLVANIA ELECTRONIC SYSTEMS

4. "The Use of Carmonette in Evaluating the Effectiveness of Night Vision Devices"
   NORMAN W. PARSONS
   RESEARCH ANALYSIS CORPORATION

5. "STOPS: A Stability Operations Simulation"
   R.E. ZIMMERMAN
   RESEARCH ANALYSIS CORPORATION

SESSION D - URBAN GAMING

JOANN LANGSTON, SESSION CHAIRMAN

TOPIC QUESTION: "How practical are urban games?"

1. "The Design Dilemma: Games for Whom?"
   HAROLD W. ADAMS
   GRADUATE SCHOOL OF PUBLIC AFFAIRS

2. "Gaming Simulation of Urban Spatial Processes"
   BARRY M. KIBEL
   EBS MANAGEMENT CONSULTANTS

3. "The Connecticut Game"
   DENNIS LITTLE
   INSTITUTE FOR THE FUTURE

4. "Fun City: An Urban Planning Game"
   DAVID SEADER
   THE MITRE CORPORATION,
   K. MICHAEL BURKE

5. "Two Urban Election Simulations and Urban Analysis"
   MARSHALL H. WHITHED
   RENSSELAER POLYTECHNIC INSTITUTE,
   CLIFFORD N. SMITH
   NORTHERN ILLINOIS UNIVERSITY

6. "Urban Game Design"
   PARIS GLENDENING
   UNIVERSITY OF MARYLAND

COCKTAIL RECEPTION

(BRITTANY ROOM)

6:30 P.M.

BANQUET
(NORMANDY & SAVOY ROOMS)

7:30 P.M. - 9:30 P.M.

1. CHAIRMAN'S OPENING REMARKS
   PETER W. HOUSE, PRESIDENT
   ENVIROMETRICS, INCORPORATED

2. GREETINGS FROM THE HOST
   THOMAS FLEMING, PRESIDENT
   SCIENTIFIC RESOURCES CORPORATION

3. GUEST SPEAKER
   ORVILLE L. FREEMAN, PRESIDENT
   EDP TECHNOLOGY INTERNATIONAL, INC.

SUNDAY MORNING SESSIONS

9:30 A.M. - 11:30 A.M.

SESSION A - VALIDITY OF GAMING
(SAVOY ROOM)

MARTIN BROSSMAN, SESSION CHAIRMAN

TOPIC QUESTION: "WHY AND HOW SHOULD GAMES BE VALIDATED?"

1. "THE NEED FOR GAME VALIDATION"
   JAMES DWYER
   JOINT WAR GAMES AGENCY
   OFFICE OF JOINT CHIEFS OF STAFF

2. "PROBLEMS IN VALIDATION OF FUTURE CONCEPTS"
   NORMAN FARRELL
   COMBAT DEVELOPMENTS COMMAND

3. "VALIDATION OF COMBAT MODELS AGAINST HISTORICAL DATA"
   WILLIAM FAIN, JANICE FAIN
   CONSOLIDATED ANALYSIS CENTERS, INC.,
   LEON FELDMAN, SUSAN SIMON
   CENTER FOR NAVAL ANALYSES

4. "FITTING KOREAN WAR DATA BY STATISTICAL METHODS"
   JOHN OVERHOLT
   CENTER FOR NAVAL ANALYSES

5. "INDUSTRIAL MANAGEMENT TRAINING GAMES - THEIR USE AND VALIDATION"
   VIRGIL REHG
   AIR FORCE INSTITUTE OF TECHNOLOGY
   WRIGHT-PATTERSON AIR FORCE BASE

SESSION B - USES AND USERS
(NORMANDY ROOM)

GORDON SMITH, SESSION CHAIRMAN

TOPIC QUESTION: "WHEN WILL GAMING DEVELOP FROM A RESEARCH AND EDUCATION INTO A DECISION-MAKING TOOL?"

1. "MODELING THE FIRE PROTECTION DELIVERY SYSTEM"
   DENNIS J. CORELIS, ROBERT J. ESPOSITO AND EDWARD M. GANS
   RENSSELAER POLYTECHNIC INSTITUTE
2. "SIMULATION GAMES IN SOCIAL SCIENCE TEACHING AND RESEARCH"
   FRANK B. HORTON III
   ALAN R. THOENY
   U.S. AIR FORCE ACADEMY
3. "LEARNING GAMES IN THE DEPAUL COLLEGE"
   NANCY KLEIN
   DEPAUL UNIVERSITY
4. "SIMULATION IN BEHAVIORAL RESEARCH AND TRAINING IN THE FIELD OF SPECIAL EDUCATION ADMINISTRATION"
   DANIEL D. SAGE
   SYRACUSE UNIVERSITY

GAMING DEMONSTRATIONS
(BRITTANY ROOM)

1:00 P.M. - 3:00 P.M.

BRIDGE PLAYING GAME
WINSTON RILEY III
RILEY SYSTEMS,
THOMAS A. THROOP
RESEARCH ANALYSIS CORPORATION

BUILD - A COMMUNITY DEVELOPMENT SIMULATION GAME
J. A. ORLANDO
A. J. PENNINGTON
DREXEL INSTITUTE OF TECHNOLOGY

GENERAL ELECTRIC MANAGEMENT GAME
GENERAL ELECTRIC COMPANY

CZECHOSLOVAKIA 1968: A SIMULATION
JOHN P. MCABEE
BOSTON UNIVERSITY

MISCELLANEOUS INFORMATION

HOTEL SONESTA TELEPHONE
(202) 783-4600

SOCIAL AND RECREATIONAL ACTIVITIES

COMPLETE INFORMATION ON SIGHTSEEING TOURS AND THE MANY RECREATIONAL FAÇILITIES AVAILABLE CAN BE OBTAINED AT THE SOCIAL DIRECTOR'S DESK IN THE LOBBY. AN INFORMATION BROCHURE WILL ALSO BE FOUND IN EACH ROOM.

THE HOTEL SONESTA'S BEAUTIFUL DOMED POOL IS AVAILABLE FOR YEAR-AROUND ENJOYMENT. THE POOL HOURS ARE:

MONDAY-FRIDAY: 12 NOON TO 8:00 P.M.
SATURDAY & SUNDAY: 10:00 A.M. TO 8:00 P.M.

DINING HOURS

PINK KITCHEN COFFEE SHOP

BREAKFAST	7:00 A.M. - 11:00 A.M.
LUNCHEON	11:00 A.M. - 4:00 P.M.
DINNER	4:00 P.M. - 10:30 P.M.

BEEF N' BIRD RESTAURANT
MONDAY - FRIDAY:

LUNCHEON	12 NOON - 3:00 P.M.
DINNER	6:00 P.M. - 10:30 P.M.
SATURDAY:	6:00 P.M. - 11:45 P.M.
SUNDAY:	5:00 P.M. - 11:00 P.M.

HAYPENNY LOUNGE

MONDAY - SATURDAY:	11:00 A.M. - 2:00 A.M.
SUNDAY:	12 NOON - 12 MIDNIGHT